बुलेटिन
नेपाल भौगर्भिक समाज

Volume 27 **April 2010 (बैशाख २०६७)**

BULLETIN
OF
NEPAL GEOLOGICAL SOCIETY

NEPAL GEOLOGICAL SOCIETY
(EST. 1980)
PO Box 231, Kathmandu, Nepal
Email: info@ngs.org.np
Website: http://www.ngs.org.np

Best Wishes
To
Nepal Geological Society

Editorial

The Editorial Board is immensely delighted to bring out this Bulletin (Volume 27) of the Nepal Geological Society. This Volume, like the previous ones, aims at updating the readers on the regular activities of the Society, and it also contains scientific articles on various topics of interest, abstracts of the papers presented on ISDR Day -2009 and other Scientific Talk Programmes which, we believe, to be of great value to the readers.

Our sincere thanks are due to all the authors who have contributed their valuable papers to this volume. Similarly, we would like to thank all the members of the Society for their cooperation. The Editorial Board, on behalf of the Nepal Geological Society, gratefully acknowledges the financial and technical supports from the consulting firms, agencies and organizations.

We hope that the readers will find this volume to be useful and informative. Comments and suggestions for the further improvement of the Bulletin are highly welcomed.

Thank you! **– Editors**

NEPAL GEOLOGICAL SOCIETY

14th EXECUTIVE COMMITTEE

September 2009 – August 2011

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LIST OF PUBLISHED JOURNALS OF NEPAL GEOLOGICAL SOCIETY

1. Journal of Nepal Geological Society, Vol. 39, June 2009
2. Journal of Nepal Geological Society (Proceedings of International Workshop on Seismology, Seismotectonics, and Seismic Hazard in Nepal Himalaya, 28–29 November 2006 and Fifth Nepal Geological Congress on Geology, Environment, and Natural Hazards Mitigation: Key to National Development, 26–27 November 2007), Vol. 38 (Special Issue), December 2008
3. Journal of Nepal Geological Society, Vol. 37, June 2008
4. Journal of Nepal Geological Society (Abstracts of Fifth Nepal Geological Congress on Geology, Environment, and Natural Hazards Mitigation: Key to National Development, 26–27 November 2007), Vol. 36 (Special Issue), November 2007
5. Journal of Nepal Geological Society, Vol. 35, June 2007
6. Journal of Nepal Geological Society (Proceedings of Fifth Asian Regional Conference on Engineering Geology for Major Infrastructure Development and Natural Hazards Mitigation, 28–30 September 2005), Vol. 34 (Special Issue), December 2006
7. Journal of Nepal Geological Society, Vol. 33, June 2006
8. Journal of Nepal Geological Society (Abstracts of Fifth Asian Regional Conference on Engineering Geology for Major Infrastructure Development and Natural Hazards Mitigation, 28–30 September 2005), Vol. 32 (Special Issue), September 2005
9. Journal of Nepal Geological Society, Vol. 31, June 2005
10. Journal of Nepal Geological Society (Proceedings of Fourth Nepal Geological Congress, 9–11 April 2004), Vol. 30 (Special Issue), December 2004
11. Journal of Nepal Geological Society, Vol. 29, June 2004
12. Journal of Nepal Geological Society, Vol. 28, June 2003
13. Journal of Nepal Geological Society (Proceedings of Third Nepal Geological Congress, 26–28 September 2001, Kathmandu, Nepal), Vol. 27 (Special Issue), December 2002
14. Journal of Nepal Geological Society, Vol. 26, June 2002
15. Journal of Nepal Geological Society (Proceedings of Workshop on the Himalayan Uplift and Palaeoclimatic Changes in Central Nepal, 10 November 2000), Vol. 25 (Special Issue), December 2001
16. Journal of Nepal Geological Society (Abstract Volume of Third Nepal Geological Congress, 26–28 September 2001), Vol. 24 (Special Issue), September 2001,
17. Journal of Nepal Geological Society, Vol. 23, June 2001
18. Journal of Nepal Geological Society (Proceedings of International Symposium on Engineering Geology, Hydrogeology, and Natural Disaster with Emphasis on Asia, 28–30 September 1999, Kathmandu, Nepal), Vol. 22 (Special Issue), December 2000
19. Journal of Nepal Geological Society, Vol. 21, June 2000
20. Journal of Nepal Geological Society (Abstract Volume of International Symposium on Engineering Geology, Hydrogeology, and Natural Disaster with Emphasis on Asia, 28–30 September 1999, Kathmandu, Nepal), Vol. 20 (Special Issue), 1999
21. Journal of Nepal Geological Society, Vol. 19, 1999
22. Journal of Nepal Geological Society (Proceedings of Second Nepal Geological Congress, 1995), Vol. 18 (Special Issue), 1998
23. Journal of Nepal Geological Society, Vol. 17, 1997
24. Journal of Nepal Geological Society (Abstract Volume of Second Nepal Geological Congress), Vol. 16 (Special Issue), 1997
25. Journal of Nepal Geological Society, Vol. 15, 1997
26. Journal of Nepal Geological Society (Proceedings of First Nepal Geological Congress, 1995), Vol. 14 (Special Issue), 1996
27. Journal of Nepal Geological Society, Vol. 13, 1996
28. Journal of Nepal Geological Society (Abstract Volume of First Nepal Geological Congress, 1995), Vol. 12 (Special Issue), 1995

29. Journal of Nepal Geological Society (Proceedings of 9th Himalaya–Karakoram–Tibet Workshop, 1994), Vol. 11 (Special Issue), 1995
30. Journal of Nepal Geological Society, Vol. 10, 1995
31. Journal of Nepal Geological Society (Abstracts of 9th Himalaya– Karakoram–Tibet Workshop, 1994), Vol. 10 (Special Issue), 1994 29
32. Journal of Nepal Geological Society, Vol. 9, 1993
33. Journal of Nepal Geological Society, Vol. 8, 1992
34. Journal of Nepal Geological Society, Vol. 7, 1991
35. Journal of Nepal Geological Society, Vol. 7 (Special Issue), 1991
36. Journal of Nepal Geological Society, Vol. 6, 1989
37. Journal of Nepal Geological Society, Vol. 5, No. 1, 1988
38. Journal of Nepal Geological Society, Vol. 4 No. 1 & 2, 1987
39. Journal of Nepal Geological Society, Vol. 4 (Special Issue), 1984*
40. Journal of Nepal Geological Society, Vol. 3, No 1 & 2, 1985
41. Journal of Nepal Geological Society, Vol. 2 No. 2, 1985
42. Journal of Nepal Geological Society, Vol. 2 (Special Issue), 1982*
43. Journal of Nepal Geological Society, Vol. 2, No. 1, 1981
44. Journals of Nepal Geological Society, Vol. 1, No. 2, 1981*
45. Journal of Nepal Geological Society, Vol. 1, No. 1, 1981*

*Out of prints (only photocopy available upon request.)

CONTENTS

NGS NEWS

The 31st Annual General Body Meeting (AGM) and biennial function of the Nepal Geological Society (NGS) were held in the auditorium hall of the United World Trade Center, Tripureshwor, Kathmandu on 30th August 2009 (B. S. 2066 Bhadra 14). President of the 13th Executive Committee Professor Dr. Megh Raj Dhital chaired the General Body Meeting. The meeting began with the welcome speech by Professor Dhital. Dr. Danda Pani Adhikari, General Secretary, presented the Annual Report to the General Body highlighting the various activities and events which happened during the tenure of the 13th Executive Committee. Then, Mr. Dharma Raj Khadka, Treasurer, presented the Financial Report, including the Auditor's Report, for the Fiscal year 2065/066 B. S. Following the presentation of the General Secretary and Treasurer, a lively discussion session was held on various issues to address the question of NGS members in connection with the Annual and financial reports. After long discussion both the reports presented by the General Secretary and Treasurer were approved by the AGM. With the recommendation of the Executive Committee, the AGM decided to appoint Mr. Keshab Bhattarai as new auditor for the year 2066/2067. More than 150 NGS members participated the meeting.

The Nepal Geological Society had conferred upon the NGS Honourary Fellowship 2066 to Professor Dr. Gerhad Fuchs of University of Vienna, Austria and Professor Dr. Madhab Prasad Sharma, Trubhuvan University, Nepal in recognition of their contribution towards scientific research and development in the Himalaya. The fellowship announcement was made on the occasion of 31st Annual General Body Meeting of NGS that held on 31st August 2009.

Other issues discussed in the meeting were preparation of the Sixth Nepal Geological Congress to be held in 2010, land and building management activities, NGS publications and its regularity and marketing, code of conduct and ethics, improvement of website and e-mailing system, scientific talk program, fulfilling vacant and creating new positions in government offices, creating new positions in local government bodies, 14th Executive Committee election, formation of Mitra Rai Fellowship Trust, and 2009 ISDR-Day celebration. At the end, Professor Dhital concluded the General Body Meeting with thanking all the NGS members and other organizations for their supports on various ways.

The second part of the program was biennial function and office handover ceremony. President elect, Mr Jagadish Shrestha chaired the program. Honorable Dr. Yuba Raj Khatiwada, Vice Chairman, National Planning Commission, Nepal, was the Chief Guest, and Honorable Dr. Dinesh Chandra Devkota, member, National Planning Commission, Nepal and Professor Dr. Madhab Prasad Sharma, Vice Chancellor, Tribhuvan University, Nepal were the guests.

The election for the 14th Executive committee was planned to be held on Bhadra 12, 2066 and in the last day of filing nomination for executive positions (Shravan 28, 2066) NGS Election Committee coordinated by Mr. Gyani Raja Chitrakar declared unanimous selection of all eight candidates. The newly elected 14th Executive Committee included Mr. Jagadishwor Nath Shrestha, President; Mr. Shysm Bahadur K. C., Vice- President; Dr. Dinesh Pathak, General Secretary; Mr. Dinesh Napit, Treasurer; Mr. Swostik Kumar Adhikari, Deputy General Secretary; and Mr. Pramod Simkhada, Mr. Trilok Chandra Bhatta and Mr Ujwal Raghubanshi as members.

Honorable Dr. Khatiwada highlighted the importance of geology and role of geological community in nation development. Similarly, Professor Sharma and Dr. Devkota also addressed the function with their remarks and encouraged the NGS members for their positive contribution from their respective places. NGS President Professor Megh Raj Dhital mentioned about the history of NGS and the main activities the 13th Executive Committee performed. Professor Dhital also thanked the members for their cooperation during his presidency and congratulated the newly elected committee and expressed best wishes.

In the meeting the Society acknowledged Dr. Santa Man Rai, Coordinator, NGS Scientific sub-Committee with an appreciation letters for his contribution to strengthen scientific activities of the NGS, including organizing scientific talk program. Similarly, Dr. Kamala Kanta Acharya and Mr. Niraj Kumar Regmi were also acknowledged with appreciation letters for their assistance in the editorial works of the NGS publications. The Chief Guest distributed the certificates to Dr. Rai, Dr. Acharya and Mr. Regmi.

President elect Mr. Jagadish Shrestha addressed the function and spoke briefly about the plan and program and the direction the newly elected Executive Committee will take to lead the Society in the coming days. Mr. Shrestha finally thanked to all the participants and concluded the meeting.

Nepal Geological Society in association with Mitra Kunj

and Russian Centre for Science and Culture observed the **International Strategy for Disaster Risk Reduction (ISDR) - Day 2009** with a half day workshop on the UN theme "Hospital Safe from Disasters: Reduce Risk, Protect Health Facilities, Save Lives" on October 28, 2009 at Russian Centre for Science and Culture. The inaugural session of the Workshop was chaired by Mr. Jagadish Shrestha, President, NGS and the Chief Guest Dr. Govinda Kusum, Sectetary, Ministry of Home Affairs, Government of Nepal inaugurated it. Four thematic papers were presented in the technical session, and there were more than 100 participants in the Workshop.

The International Workshop on Himalaya, Karakoram and Tibet (HKT) was held in San Francisco, USA in June 2010, and three NGS members namely, Professor Dr. Bishal Nath Upreti, Dr. T. P. Ojha and Mr. Som Nath Sapkota participated the Workshop. With the decision of the 14th Executive Committee of NGS, Professor Upreti in the San Francisco workshop proposed the interest of NGS to organize the 2012 HKT in Nepal. There was a positive response on the proposal.

31ST ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

Annual Report by Dr. Danda Pani Adhikari, General Secretary, NGS delivered to the 31st Annual General Body Meeting

30th August 2009 (14 Bhadra 2066)

United World Trade Center, Tripureshwor, Kathmandu, Nepal

Respected Chairman
Honorary Fellows of the NGS
Respected Past Presidents
NGS members and
Ladies and Gentlemen
Namaste and Good afternoon!

It is a great pleasure of the 13th Executive Committee of the Nepal Geological Society (NGS) and me to welcome you all in the 31st Annual General Body Meeting (AGM) of the NGS. On this occasion, I would like to mention the main activities of the 13th Executive Committee performed in the second year of its tenure.

Preparation of Sixth Nepal Geological Congress

The 13th Executive Committee initiated process to mark its 30th Anniversary by organizing Sixth Nepal Geological Congress in 2010. The Committee appointed Mr. Krishna Prasad Kaphle, past NGS President as the Congress Convener and Dr. Santa Man Rai and Mr. Shyam Bahadur KC as Co-Conveners. Mr. Kaphle and his team, in close coordination with the Executive Committee, worked out and decided the Congress date ***(15-17 November, 2010)*** and theme ***(Geology, Natural Resources, Infrastructures, Climate Change and Natural Disaster).***

Organizing Special General Body Meeting

The Society convened special General Body Meeting in Paush 14, 2066 BS as it felt an immediate need to make decisions on the issues of tenure of Executive Committee, land purchasing and selling right of the Society, and number of Honorary fellowships the Society can confer in a year.

Initially, tenure of the Executive Committee was for two years and later it was changed into three years, but there were voices that three years period was long and ineffective. The issue was discussed and the meeting decided two year tenure for each Executive Committee effective from the 13th Executive Committee. The special meeting also decided that the Society needs right to buy and sell land for its building construction purpose. With regard to the number of Honorary Fellowships, the Special General Body Meeting concluded that under the recommendation of Executive Committee the NGS general body could honor maximum of two fellows who made outstanding contribution in the field of geological science in the Himalaya.

In that occasion, a condolence meeting was held in memory of late Dr. Jovan Stocklin, a Swiss national and Honorary Fellow of NGS. Late Dr. Stocklin was passed away in 15 April 2008.

Third amendment of NGS Statute

Third amendment of the NGS statute was made with three major changes (the tenure of the Executive Committee, land purchasing and selling right and number of honorary fellowships as decided by the Special General Body Meeting) and some minor changes and published the statute in the form of a booklet.

Efforts on managing/buying land

The Land and Building Management Committee made big efforts to manage government/buy private land for NGS building construction. However, the Committee could not manage it due to financial constraints.

Organizing Scientific Talk Program

The Scientific Committee of NGS, under the leadership of Dr. Santa Man Rai, organized Scientific Talk Program. Nine research papers were presented and government officers, researchers, academia and students were benefited from the talks.

Selection of Honorary Fellows

The Society appointed past NGS presidents, Prof Dr. Bishal Nath Upreti and Mr. Krishna Prasad Kaphle to recommend possible candidate(s) for the NGS Honorary Fellowship 2066. Based on the suggestion of the recommendation committee, the 13th Executive Committee proposed Professor Dr. Gerhard Fuchs, University of Vienna, Austria and Professor Dr. Madhab Prasad Sharma, Tribhuvan University, Nepal to be honored with NGS Honorary Fellowship 2066. The meeting endorsed the proposal of the society.

ISDR-Day Celebration

As in the previous years, ISDR Day-2008 was observed by organizing one day workshop on 22 October, 2008. The theme of the workshop was "**Koshi Disaster of 2008**". NGS organized the workshop in collaboration with DPNet Nepal, Ministry of Home Affairs (MOHA), Society of Irrigation Engineers, Nepal (SIREN), Department of Hydrology and Meteorology (DHM), Department of Mines and Geology (DMG) and Tribhuvan University (TU). Eight papers on Koshi Disaster related issues were presented and more than 150 participants from different organizations attended the Workshop. The papers presented in the workshop were much appreciated by the participants as Koshi Disaster of 2008 was a national issue.

Earthquake –Day Celebration

11th Earthquake–Day celebration was held on Magh 2-4, 2066 BS with "Earthquake Safety Exhibition" at Bhugol Park, New Road, Kathmandu. It was jointly organized by NSET Nepal, MOHA and Lalitpur Sub-Metropolis. Nepal Geological Society actively participated in the exhibition with its publication display.

Hold election of the 14th Executive Committee

The Society formed an Election Committee under the leadership of Mr. Gyani Raja Chitrakar to hold election of the 14th Executive Committee. The Election Committee in close coordination with the Executive Committee made all necessary preparation to hold election on Bhadra 12, 2066 BS. The outcome of the election was declared as unanimous selection of all candidates.

Other activities

Other activities of the NGS include publication of its Journal, Bulletin and brochure, formation of committee to develop code of conduct and ethics, improvement of website and e-mailing system, visiting Government Organizations to request to fulfill vacant and create new positions in government offices. Registration of NGS with Social Service Coordination Council (Samagic Sewa Samanwaya Parishad), Renewal of the Society with the District Administration Office and District Development Committee, Kathmandu, selling its publications and correspondence with different organizations were some of the other regular activities. NGS membership expansion was significant as 60 more members joined the Society in the last two years.

Jaya Geoscience!Jaya NGS and NGS Members!

Thank you.

Annual Financial Report by Mr. Dharma Raj Khadka, Treasurer, NGS presented during the 31st Annual General Body Meeting

नेपाल भौगर्भिक समाजका कोषाध्यक्ष श्री धर्मराज खड्काद्वारा प्रस्तुत आर्थिक प्रतिवेदन

यस सभाका सभापतिज्यू
सम्मानित सदस्यज्यूहरू
यस समाजका पूर्व अध्यक्षज्यूहरू
वर्तमान कार्यकारिणी समितिका साथीहरू
एवं सम्पूर्ण सदस्यज्यूहरू ।

यस १३ औ कार्यकारिणी समितिले आ. व. २०६५।०६६ को एक बर्षको कार्यकालमा गरेको आर्थिक विवरणलाई अधिकार प्राप्त लेखा परीक्षकबाट परीक्षण समेत गराई यस समाजको ३१ औ साधारण सभा समक्ष विगत बर्षमा जस्तै गरी तपाईहरू समक्ष पेश गर्न लागेको छु ।

यसका मूख्य शिर्षकहरूमा भएको Income and expenditure तथा Receipt and Payment सम्बन्धी संक्षिप्त झलक तपाईहरू समक्ष पेश गरी नै सकेको छु । अब म यस सम्बन्धी मोटामोटी विवरण उल्लेख गर्न अनुमति चाहान्छु ।

२०६५ असार मसान्त (गत आ. व. को अन्त्य) सम्मको Opening बैंक मौज्दाद रु. २३,६८,३८३।४२

यस आ. व.२०६५।०६६ मा भएको आम्दानी र खर्च

आम्दानी	रु ३,८१,३६४।८७
खर्च	रु.३,००,०९२।६५
खर्च भन्दा बढी आम्दानी	रु. ८१,२७२।२२

यस बर्षमा भएका आम्दानीहरूमा Workshop on Koshi Disaster 2008 का लागि Contribution तथा रजिष्टेसन वापत रु. ६९,०००। आम्दानी भएको छ । यस वाहेक प्रमुख अन्य आम्दानीमा Journal sale वाट रु. ३५,९५०।, Life members तथा अन्य Life Membership fee वापत रु. १५,१०० र अन्य आम्दानी रु. ३१,७३३।४३ रहेको छ । Difference in $ rate (78.05) वापत रु २,२९,५८१।४४ आम्दानी भएको छ ।

आदरणीय सदस्य साथीहरू,

महासचिवज्यूले उल्लेख गर्नु भएको कार्यहरू संचालन गर्न यस आर्थिक बर्षमा खर्च हुन गएको छ । जसमा मूख्य खर्चलाई मोटामोटी रूपमा यसरी विभाजन गरिएको छ ।

1. Workshop on Koshi Disaster 2008/ Hospitality = Rs. 55,150.00
2. Printing Vol. 34, Bull. Vol. 25, Booklet, Membership Directory = Rs. 1,54,918.00
3. Miscellaneous exp. = Rs. 62,024.65 (Bank charge, fuel, tax on interest, society renewal, ISDR expense, scientific talk program, internet, web hosting, Communication etc.

यस प्रकार, Income over expenditure Rs. 81272.22 रहन गएको छ,। संक्षिप्तमा हेर्दा समाजसँग हाल नगद Closing Balance जम्मा रु. २४,४९,४५५।६४ रहेको छ ।

नेपाल भौगर्भिक समाजका जिन्सी सामानहरू सम्बन्धी संक्षिप्त झलक :

SN	Particulars	Nos.
1	Printer	3 set
2	Workshop bags	15
3	Tin Box	1
4	Steel Daraj	4
5	Wooden Bookshelves	3
6	Table	1
7	Chairs	11
8	Steel Bookshelve	1
9	Computer	3 set
10	Phone	1 set
11	Journals vol 1 to vol 38	5131

NGS Office and Editorial Board

अन्त्यमा, यो विवरण सदस्यज्यूहरू समक्ष प्रतिक्रिया तथा सुझावका लागि अपेक्षा गर्दछु ।
धन्यवाद ।

धर्मराज खडका
कोषाध्यक्ष
नेपाल भौगर्भिक समाज
२०६६।५।१४

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Auditor's Financial Report (FY 2065/66 B.S.)

Babu Raja Bajracharya
Registered Auditor

11th Bhadra 2066

The Members
Nepal Geological Society
Kathmandu.

Gentlemen,

I have audited the attached Receipt and Payment Account for the year ended 31st Asar 2066 and report as follows:

1. I have got all the information and explanations which are required for the purpose of audit.
2. Proper books as required are maintained according to Society's Rule & Regulations.
3. The attached Receipt and Payment Account and Income and Expenditure Account are drawn properly up in accordance with records which are made available.
4. According to the information given to me the attached Income and Expenditure Accounts prepared for the year ended 31st Asar 2066 exhibit true and fair view.

Babu Raja Bajracharya
Registered Auditor

116 Teenkune Marga, Kuleswor, Kathmandu
Phone : 4282390

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NEPAL GEOLOGICAL SOCIETY
INCOME AND EXPENDITURE ACCOUNT
For the year ended 31st Asar 2066

EXPENDITURE	AMOUNT	INCOME	AMOUNT
To Advance	53,415.00	By Contribution	60,000.00
To Advertisement	5,085.00	By Entrance Fee	400.00
To Audit Fee	5,000.00	By Interest received	11,477.59
To Bank Charge	500.00	By Interest received ($171.40)	13,377.77
To Hospitality	55,150.00	By Journal Sale	35,950.00
To Printing	154,918.00	By Journal Subscription	500.00
To Remuneration, wages	22,500.00	By Life Membership fee	15,100.00
To Tax on interest	1,517.20	By Miscellaneous Income	3,711.50
To Tax on interest ($25.72)	2,007.45	By Miscellaneous Income ($29.04)	2,266.57
		By Registration	9,000.00
		By Excess of Expenditure Over Income	148,309.22
Total	**300,092.65**	**Total**	**300,092.65**

Note : US $ 1 = NRs.78.05

Treasurer	General Secretary	President	Auditor
D.R. Khadka	D.P.Adhikari	M.R.Dhital	B.R. Bajracharya

NEPAL GEOLOGICAL SOCIETY
RECEIPT AND PAYMENT ACCOUNT
For the year ended 31st Asar 2066

RECEIPT	AMOUNT	PAYMENT	AMOUNT
To Bank (opening)	2,368,383.42	By Advance	53,415.00
To Contribution	60,000.00	By Advertisement	5,085.00
To Entrance Fee	400.00	By Audit Fee	5,000.00
To Interest received	11,477.59	By Bank Charge	500.00
To Interest received ($171.40)	13,377.77	By Hospitality	55,150.00
To Journal Sale	35,950.00	By Printing	154,918.00
To Journal Subscription	500.00	By Remuneration, wages	22,500.00
To Life Membership fee	15,100.00	By Tax on interest	1,517.20
To Miscellaneous ($29.04)	2,266.57	By Tax on interest ($25.72)	2,007.45
To Miscellaneous Income	3,711.50	By Agri. Dev. Bank (Fixed)	55,000.00
To Registration	9,000.00	By Agri. Dev. Bank (Saving)	8,049.24
To Difference in $ Rate	229,581.44	By Nabil Bank ($23691.10)	1,849,090.36
		By Nabil Bank (Fixed)	29,000.00
		By Nabil Bank (Saving)	443,744.05
		By Nepal Bank (Current)	9,949.68
		By Nepal Bank (Saving)	54,822.31
Total	**2,749,748.29**	**Total**	**2,749,748.29**

Note : US $ 1 = NRs.78.05

Treasurer	General Secretary	President	Auditor
D.R. Khadka	D.P.Adhikari	M.R.Dhital	B.R. Bajracharya

NEPAL GEOLOGICAL SOCIETY
TRIAL BALANCE
For the year ended 31st Asar 2066

ACCOUNT HEAD	AMOUNT	ACCOUNT HEAD	AMOUNT
Advance	53,415.00	Entrance Fee	400.00
Advertisement	5,085.00	Journal Subscription	500.00
Audit Fee	5,000.00	Miscellaneous Income	3,711.50
Bank Charge	500.00	Registration	9,000.00
Hospitality	55,150.00	Interest received	11,477.59
Printing	154,918.00	Interest received ($171.40)	13,377.77
Remuneration, wages	22,500.00	Life Membership fee	15,100.00
Tax on interest	1,517.20	Journal Sale	35,950.00
Tax on interest ($25.72)	2,007.45	Contribution	60,000.00
Agri. Dev. Bank (Fixed)	55,000.00	Miscellaneous Income ($29.04)	2,266.57
Agri. Dev. Bank (Saving)	8,049.24	Bank (opening)	2,368,383.42
Nabil Bank ($23691.10)	1,849,090.36	Difference in $ Rate	229,581.44
Nabil Bank (Fixed)	29,000.00		
Nabil Bank (Saving)	443,744.05		
Nepal Bank (Current)	9,949.68		
Nepal Bank (Saving)	54,822.31		
Total	**2,749,748.29**	**Total**	**2,749,748.29**

Note : US $ 1 = NRs.78.05

Treasurer	General Secretary	President	Auditor
D.R. Khadka	D.P.Adhikari	M.R.Dhital	B.R. Bajracharya

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BIENNIAL MEETING AND OFFICE HANDOVER CEREMONY OF THE NEPAL GEOLOGICAL SOCIETY

Speech by Mr. Jagadish N. Shrestha, Newly Elected President of 14th Executive Committee of Nepal Geological Society during the Office Handover Programme

नमस्कार,

अत्यन्त ठूलो विश्वासका साथ निर्विरोध निर्वाचन गरी आउँदो दुई बर्ष नेपाल भौगर्भिक समाजको सेवा गर्ने अवसर प्रदान गर्नु भएकोमा समाजका सम्पूर्ण सदस्य साथीहरू समक्ष सर्वप्रथम नयाँ १४ औं कार्यकारिणीका सदस्यहरू तथा आफ्नो तर्फबाट धन्यवाद ज्ञापन गर्न चाहन्छु ।

केही क्षण अघिमात्र नेपाल भौगर्भिक समाजको १३ औं कार्यकारिणी समितिले आफ्नो जिम्मेवारी १४ औं कार्यकारिणी समितिका म र मेरो टोलीका साथीहरूलाई हस्तान्तरण गऱ्यो । यस पलदेखि म र मेरो साथीहरूको काँधमा आउँदो दुई वर्षको लागि समाजका सम्पूर्ण कामकारवाही सफलतापूर्वक सम्पन्न गरी समाजलाई अगाडि बढाउने गहन जिम्मेवारी आइपुगेको छ । साथीहरू, कार्यकारिणीका म लगायत सबै सदस्यहरूले यो जिम्मेवारीको गहनतालाई राम्ररी बुझेका छौं । हामी हाम्रो बलबुता र सामर्थ्यले भ्याएसम्म यो जिम्मेवारी सफलतापूर्वक पूरा गर्ने प्रयत्न गर्नेछौं । यस अवसरमा म सदस्य साथीहरूलाई १४ औं कार्यकारिणीलाई कार्यभार जिम्मा लगाएपछि निर्धक्क भएर बस्न पाउनु हुन्न पनि भन्न चाहन्छु । तपाईंहरूको अनुभवबाट कार्यकारिणीले निरन्तर सहयोग, निर्देशन र सुझाव प्राप्त गर्नेछ र त्यसैका आधारमा कार्यसञ्चालन गर्नेछ । यो कार्यकारिणीको सफलता तपाईं हामी सबैको सफलता हो । म र मेरा सदस्य साथीहरूले तपाईंहरूलाई सहयोग र सुझावको लागि घच्घच्याइरहने छौं, तपाईंकहाँ धाई रहने छौं । सबै साथीहरू समाजको उन्नयनमा सहभागी भई दिन म अनुरोध गर्दछु ।

नेपालमा विभिन्न पेशागत समाजहरूका बीचमा नेपाल भौगर्भिक समाजको उच्च स्थान रहेको छ । विगत तीस वर्षको अवधिमा यस समाजले पेशागत अवधारणा भित्र रही आफ्नो उद्देश्य अनुरूप भौगर्भिक ज्ञानको विकास तथा भूगर्भविद, भू–प्राविधिकहरूको कल्याणको लागि काम गर्दै आइरहेको छ । गत तीस वर्षदेखि निरन्तर रूपमा प्रकासित भूवैज्ञानिक जर्नल, बुलेटिन, कैयौं राष्ट्रिय तथा अन्तर्राष्ट्रिय कङ्ग्रेस सम्मेलन आयोजना, भूवैज्ञानिक सम्मान तथा उत्थानका लागि कार्य गरी यसले नेपालको वैज्ञानिक समाजका बीचमा आफ्नो विशिष्ट स्थान बनाएको छ । यी कार्यहरू सम्पन्न गर्ने यस अघिका तेह्र वटै कार्यकारिणीका सदस्य साथीहरूलाई म हार्दिक धन्यवाद र बधाई ज्ञापन गर्न चाहन्छु । र त्यही पदचिन्हलाई पछ्याउँदै अझ अगाडि बढ्ने प्रतिबद्धता व्यक्त गर्दछु ।

अब म नयाँ कार्यकारिणीले गर्ने कार्ययोजना बारे छोटकरीमा भन्न चाहन्छु । पहिले त नयाँ कार्यकारिणीले जर्नल प्रकाशनलाई विशेष प्राथमिकता दिई निरन्तरता दिनेछ । समाजको छैठौं भौगर्भिक कङ्ग्रेस आगामी बर्ष सम्पन्न गर्न १३ औं कार्यकारिणीले गरेको गृहकार्यलाई निरन्तरता दिँदै आवश्यक साधन र स्रोत जुटाउनेछ । त्यस्तै समाजले गर्दै आएका विभिन्न व्याख्यान सभा (Talk programme) गर्ने, अन्तर्राष्ट्रिय प्रकोप न्यूनीकरण दिवस (ISDR Day) मनाउने, सभासम्मेलनमा भाग लिने, आदि कार्यलाई निरन्तरता दिइनेछ ।

नेपाल भौर्गभिक रूपले अत्यन्त कमजोर, प्राकृतिक प्रकोपग्रस्त देश हो । त्यसैले यहाँ प्राकृतिक प्रकोप न्यूनीकरण कार्यको आफ्नै महत्व छ । त्यसका लागि हाम्रो समाजले अन्य पेशागत संस्थाहरूसँग मिलेर भूकम्प, अग्नी एवं जलप्रकोप सम्बन्धी चेतनामूलक कार्यक्रम (Public Awareness) गर्ने, पुस्तिका प्रकाशन गर्ने, जिल्ला स्तरीय तालिम सञ्चालन गर्ने कार्यहरू गर्नेछ । यसका लागि विभिन्न पेशागत संस्था एवं सरकारी तथा गैरसरकारी संस्थाहरूसँग समन्वयात्मक सम्बन्ध विस्तार गरिनेछ । त्यस्तै समाजले UNDP सँग मिलेर गरेको Disaster Data Source लाई Update गर्ने कार्य सम्पन्न गर्नेछ ।

सडक विभाग जस्ता कतिपय अत्यन्त महत्वपूर्ण निकायहरूमा भूवैज्ञानिकहरूको अभाव छ । भूबनोटको अध्ययन नगरी सडक निर्माण गर्नाले पहिरो, बाढी तथा भूक्षयमा बढोत्तरी भई वर्षेनी सयौंको ज्यान तथा अरबौको धनमाल क्षति हुने गरेको छ । त्यसैले भूगर्भसँग सम्बन्धित सबै सरकारी र गैरसरकारी निकायहरूमा भूवैज्ञानिकहरूको प्रतिनिधित्व गराउन विशेष पहल गर्नेछ ।

समाजको आफ्नै स्थायी कार्यालय भवन नहुँदा अत्यन्त कठिनाई भैर हेको तथ्य कसैबाट लुकेको छैन । नेपाल सरकारले विभिन्न पेशागत समुहहरू जस्तै इन्जिनियरिङ एसोसिएसन, बार एसोसिएसन, रेन्जर्स एसोसिएसनलाई उपलब्ध गराइदिए जस्तै नेपाल भौगर्भिक समाजलाई एक टुक्रा जमिन उपलब्ध गराउन यसै मञ्चबाट म नेपाल सरकारलाई आग्रह गर्दछु । समाजको भवन बनाउन निर्माण समिति बनाई कार्यारम्भ गरिनेछ ।

नेपालका विभिन्न पेशागत संस्थाहरूले आ–आफ्नै तरिकाले कार्य गदै आइरहेका छन् । ती सबैलाई सकेसम्म एकबद्ध गर्दै सबै प्रकारका वैज्ञानिकहरूको प्राज्ञिक उत्थानबाट देश विकासमा अझ बढी योगदान पुऱ्याउने प्रयत्न गरिनेछ । देशका सबै पेशागत समाजहरूको सञ्जाल स्थापना गर्ने तर्फ पाइला चालिनेछ ।

समाजले आफ्ना कार्यक्रम विभिन्न उपसमिति मार्फत गदै आइरहेको

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सन्दर्भमा विगतका कतिपय उपसमितिहरूले विभिन्न कारणले राम्ररी कार्य सम्पादन गर्न सकेको देखिदैन । तसर्थ उपसमितिहरूलाई कसरी पुनर्जीवन दिने भन्ने यक्षप्रश्न हाम्रो अगाडि छ । यसतर्फ विशेष पहल गरिने छ । समाजलाई स्थापनाकालदेखि प्राज्ञिक र आर्थिक सहयोग गर्दै आउनु भएका सम्पूर्ण सरकारी, गैरसरकारी निकायहरू, कन्सल्टेन्सीहरू, खनिज तथा खनिजमा आधारित उद्योगहरू र अन्य व्यवसायी सङ्घसङ्गठन एवं साथीहरूबाट सदाझैं आउँदा दिनहरूमा पनि सहयोग प्राप्त हुने आशा गरेको छु ।

अन्तमा यस समाजका अग्रजहरू, साथीहरू र शुभेच्छकहरूलाई प्रस्तुत कार्यक्रमबारे आफ्नो राय सुझाउ, सहयोग तथा निर्देशन दिई सहयोग गरिदिन अनुरोध गर्दै आफ्नो भनाइ यहीँ टुङ्ग्याउँछु ।

धन्यवाद ।

Speech by Honorable Dr. Yubaraj Khatiwada, Vice Chairman, National Planning Commission, Government of Nepal, during the Office Handover Programme of the Nepal Geological Society

The President Nepal Geological Society,
Vice Chancellor, Tribhuvan University,
Members of the Society,
Ladies and Gentlemen,

It is my pleasure and privilege to be invited to this installation ceremony of the 14th Executive Committee of the Nepal Geological Society. I am happy to be able to spend a few hours in this august community of geoscientists of Nepal.

First of all I would like to congratulate the newly installed 14th Executive Committee and wish them success. I wish their tenure to be fruitful.

It gives me pleasure to learn that the Nepal Geological Society had been active in development of geo-science and geoscientists in Nepal since last 30 years. The Society had been playing an important role in the development of the country by disseminating geoscientific knowledge through its scientific publications of journals and bulletins, organization of various national and international congresses, seminars workshops etc. Indeed the Society had been able to provide a common platform not only to the national scientists but also to all those geoscientists from international community who are really interested in the study of the Himalayan Geology, environment, disaster management etc. The effort of the society is really commendable. It is a pleasure to know that the newly installed Executive Committee is going to organize 6th Geological Congress in the coming year. I wish a grand success.You the geoscientists have now an obligation to carry out people's expectations in an efficient and systematic way. I hope your knowledge and capacity will be fully utilized in guiding the Nepalese society in exploration and exploitation of potential sites of such natural resources more effectively and efficiently.

As we all know the nation has embarked on the path of democracy and rapid economic development. With advent of democracy people's expectation has risen and the government is trying to fulfill those by means of economic development, which in turn entails exploitations of natural resources such as mineral and water resources. I am told time and again that Nepal is situated in a geologically fragile region. We can not change the location. We have to live with what we have. But we can make most of it. So we must be able to cope with any type of natural disaster brought in by our situation. I am happy to learn that the Society had been contributing to the mitigation of natural disaster and the coming executive committee intends to continue further this work.

I have learnt about the future plans of the society. With these sort of programs, I am sure, the society is further going to expand its activities both within and outside the country. I would like to assure you that the Government of Nepal will provide assistance to your endeavors in whatever way possible.

I once again congratulate the newly installed 14th Executive Committee and wish Mr. Shrestha and his team success in all their endeavors.

Thank You.

LIST OF COMMITTEES: THEIR ROLES AND RESPONSIBILITIES

Advisory Committee for 14th Executive Committee

Mr. G. S. Thapa
Prof. Dr. M. P. Sharma
Mr. N. D. Maskey
Dr. R. P. Bashyal
Mr. A. N. Bhandari
Prof. Dr. B. N. Upreti
Mr. K. P. Kaphle
Mr. R. K. Aryal
Mr. P. S. Tater
Prof. Dr. M. R. Dhital
Dr. Ramesh Man Tuladhar

General roles and responsibilities:

- Provides input to NGS Executive Committee towards betterment of the Society and its members.
- Provides suggestions guidelines for improving functions of different subcommittees and events of the Society.

ISDR Day Organizing Committee

Prof. Dr. M. R. Dhital (Imd. Past President)	Convener
Mr. S. M. Amatya	Member
Dr. Jaya Kumar Gurung	Member
Mr. S. Shrestha	Member
Mr. N. Shakya	Member
Mr. T. C. Bhatta (Executive Com.)	Member

General roles and responsibilities:

- Decides the activities to be carried out to celebrate the ISDR Day.
- Designs measures to raise other disaster prevention and mitigation awareness programs.
- Communicates with the concerned Government and Non-Government agencies for collaboration and funding.
- Communicates with the members/authors for contribution of articles.
- Prepares schedule and organizes the seminar/ workshop for October 28.
- Works in close coordination with NGS Executive Committee.

Communication and Information Committee

Dr. R. K. Dahal	Coordinator
Mr. D. R. Khadka	Member
Mr. S. Sapkota	Member
Mr. P. Simkhada	Member
Mr. A. Dawadi (Ex. Com)	Member

General roles and responsibilities:

- Redesigns/restructures the web site of NGS with the help of professional expert.
- Updates the website frequently.
- Updates the journal list incorporating all abstracts of each volume.
- Prepares the seminar/symposium/workshop information materials and put on the site.
- Prepares material of public interest.
- Workouts towards publicity of NGS activities in local media.
- Prepares and submits yearly work plan for next two years and expected support from the Executive Committee.

Scientific Committee

Prof. Dr. V. Dangol	Coordinator
Mr. N. R. Shrestha	Member
Dr. S. D. Shrestha	Member
Dr. D. C. Devkota	Member
Dr. T. N. Bhattarai	Member
Dr. S. Dhakal	Member
Dr. N. K. Tamrakar	Member
Mr. S. Rajaure	Member
Dr. L. P. Poudel	Member
Mr. D. Nepali	Member
Dr. D. Chamlagain	Member
Mr. S. K. Adhikari (Ex. Com.)	Member
Dr. D. Pathak (Ex. Com)	Member

General roles and responsibilities:

- Identifies and decides the issues to be incorporated in the scientific activities.
- Provides inputs to the general geo-scientific programs conducted by the Society.
- Organizes talk programs on the researches in various aspects of geological science and in relevant national issues.
- Coordinates and communicates with the researchers.
- Prepares the tentative yearly work plan for next two years and submit to Executive Committee.

Standard Development Committee

Mr. R. K. Aryal	Coordinator
Prof. Dr. B. N. Upreti	Member
Prof. Dr. M. R. Dhital	Member
Mr. J. L. Shrestha	Member

Mr. A. N. Bhandari	Member
Mr. S. Pradhan	Member
Mr. S. N. Sapkota	Member
Mr. R. Khanal	Member
Mr. U. B. Pradhananga	Member
Mr. U. B. Shrestha	Member
Mr. J. N. Shrestha (Ex. Com)	Member

General roles and responsibilities:

- Identifies the areas that need to develop standards of geo-scientific works.
- Organizes concerned experts meetings to gather information for the development of standards.
- Develops the standards as per national legal provision and communicates timely with NGS Executive Committee.
- Develops Code of Ethics for the geo-scientists.
- Prepares the tentative yearly work plan and necessary support for next two years and submits to Executive Committee.

Public Relation and Financial Committee

Mr. P. S. Tater	Coordinator
Mr. S. B. Shrestha	Member
Mr. G. S. Pokharel	Member
Mr. T. L. Adhikari	Member
Mr. D. P. Osti	Member
Mr. R. Mandal	Member
Mr. K. Kunwar	Member
Mr. J. R. Ghimire	Member
Mr. S. P. Manandhar	Member
Dr. S. Shah	Member
Mr. S. Sunuwar	Member
Mr. D. Napit	Member

General roles and responsibilities:

- Coordinates with other professional organization, I/NGO, and G/O.
- Maintains close contact with the organizations that are potential supporters in terms of technical and financial matter when needed by NGS.
- Makes complete and updated list of such organizations with full address of contact persons.
- Categorizes the organizations with respect to the possible support that NGS may receive in future.
- Helps to raise fund to conduct different activities of NGS (Seminar/Symposium/Workshop/Talk Program/Publication/material for public interest etc.)
- Plays key role in making NGS financially strong. Organizes activities to increase inter-action and relations between the members of the society as well as between the Society and other organizations.

Rules and Regulation Committee

Mr. A. N. Bhandari	Coordinator
Mr. J. R. Ghimire	Member
Mr. S. R. Sharma	Member
Mr. A. K. Dawadi	Member
Mr. Nir Shakya	Member
Mr. I. K. Shrestha	Member
Mr. Shyam KC (Ex. Com)	Member

General roles and responsibilities:

- Reviews the existing rules and regulations of NGS.
- Suggests the Ex. Com. for necessary amendment /revision.
- Prepares new rules and regulations if necessary.

Land and Building Management Committee

Mr. S. Mahato	Coordinator
Prof. Dr. B. N. Upreti	Member
Mr. S. B. Shrestha	Member
Dr. D. P. Adhikari	Member
Mr. S. R. Sharma	Member
Mr. S. Adhikari	Member
Mr. D. Napit (Ex. Com)	Member
Mr. U. Raghubansi (Ex. Com)	Member

General roles and responsibilities:

- Explores the different options towards construction of NGS building.
- Makes necessary approach to concerned organizations for acquiring land for building construction.
- Locates the areas to purchase land if necessary in order to best utilize the money of NGS.

Editorial Board of the Journal of NGS

Dr. Santa Man Rai (Nepal)	Chief Editor
Prof. Dr. Arnaud Pecher (France)	Editor
Prof. Dr. H. Sakai (Japan)	Editor
Dr. Ananta Prasad Gajurel (Nepal)	Editor
Dr. Danda Pani Adhikari (Nepal)	Editor
Dr. Khum Narayan Paudayal (Nepal)	Editor
Mr. Lila Nath Rimal (Nepal)	Editor

General roles and responsibilities:

- Plays key role in NGS publication (Journal / Bulletin/Abstract Volumes etc.).
- Organizes and performs all editorial works for publication.
- Publishes the journal/bulletin timely following standard editorial policy.
- Makes effort towards obtaining quality research papers from around the globe. For this, the board prepares a list of potential authors and reviewer and be in touch with them.

- Best utilizes the electronic media for timely publication.
- Decides the working modality within the Editorial Board members make time frame for each publication and inform Ex. Com.
- Works in close coordination with the President/ General Secretary.

International Representative

Dr. Indra Jwarchan (Australia)
Dr. Pitambar Gautam (Japan)
Dr. Damayanti Gurung (USA)
Mr. Jeewan Bajra Bajracharya (UK)
Dr. Rajeeb Gautam (Canada)

General roles and responsibilities:

- Works towards internationalizing the NGS through disseminating information about the society.
- Helps to establish contact with foreign professional societies.
- Encourages people in their contact to submit research papers in NGS Journal.
- Helps NGS to raise fund by coordinating to carry out joint activities with foreign societies/ institutions.
- Suggests Eexecutive Committee with new ideas to make its activities more efficient.

HIGHLIGHTS OF INTERNATIONAL STATEGY FOR DISASTER RISK REDUCTION DAY - 2009

Nepal Geological Society is the professional umbrella of all geologists working in Nepal and has over 600 members among which more than 170 scientists are from foreign countries. The Society was established in 1980 with the aim of developing and promoting the research and application of geological sciences to the national development through fostering high professional standard among members; promoting and protecting the professional interests of earth scientist of the country and to play an active role in the protection and conservation of environment through reducing the natural disaster.

Since its establishment, the Society has been working towards the advancement of geosciences in Nepal and is playing a leading role towards building up consensus among the government and private sectors on the role of geosciences on the national development.

NGS AND DISASTER RISK REDUCTION ACTIVITIES

The geological disaster (landslide, flood, earthquake) are the major threat to the national development and poverty alleviation in Nepal. Therefore, Nepal Geological Society initiated the advocacy in the area that included awareness campaign through the regular celebration of the International Day for Disaster Reduction (UN/IDNDR) since 1990s, occasional publication of disaster-related booklets etc. Likewise, after the establishment of UN ISDR (United nation International Strategy for Disaster Reduction), the Society has carried its activities in line with the UN/ISDR aims of building disaster resilient communities by promoting increased awareness of the importance of disaster reduction for reducing human, social, economic and environmental losses due to natural hazards and related technological and environmental disasters.

The activities of NGS towards Disaster Prevention was acknowledged by UN Humanitarian and Emergency Relief Co-ordination Office of IDNDR Secretariat in Geneva, by awarding UN-Sasakawa Disaster Prevention Award in 1998 for its efforts in disseminating the scientific knowledge and spreading the awareness of prevention of the natural disaster.

Nepal Geological Society is committed to continue to advocate for disaster risk reduction and mitigation activities in the country. This professional organization is always open to have partnership with other national and international organizations involved in this sector.

THE ISDR DAY 2009

Nepal Geological Society (NGS) is a professional organization that is committed to reduce hazard, vulnerability, and resulting disaster in the country. It has been working in disaster inventory, preparedness and advocacy since its establishment (last three decades). United Nation (UN) proclaimed the theme to celebrate disaster day 2008-2009 as: Hospitals safe from Disasters *Reduce Risk, Protect Health Facilities, Save Lives*. Giving high priority to this theme NGS organized a half day workshop entitled "*Workshop on International Day for Disaster Reduction Hospitals safe from Disasters Reduce Risk, Protect Health Facilities, Save Lives*" on October 28, 2009 in collaboration with Mitra Kunj and Russian Centre for Science and Culture.

The program was organized in the Russian Culture Center hall, Kamal Pokhari, Kathmandu. There was more than hundred participation of researchers and policy makers; those working in the disaster sectors in different aspects. The program was inaugurated and addressed by Dr. Govinda Prasad Kusum, Secretary, Minister of Home Affairs, Government of Nepal. The program was also addressed by Er. Ganesh Shah, former Minister of Science amd Technology and Environment, Government of Nepal. There were four thematic presentations, each followed by discussion over the queries of participants. The workshop was divided into two sessions namely Inauguration Session and Technical Session.

INAUGURAL SESSION

With short background on the Disaster Day, **Dr. Dinesh Pathak**, Master of Ceremony and General Secretary of NGS conducted the session and the **Chief Guest Dr. Govinda Kusum**, Secretary, Minister of Home Affairs, Government of Nepal, inaugurated the workshop.

Dr. Jaya Kumar Gurung, Co-convener of the NGS-ISDR Committee delivered welcome speech on behalf of the organizing committee. Dr. Gurung welcomed all the guests, resource persons and participants in the workshop. In his welcome speech he highlighted the need of Nepal government to deliver leadership authority to NGS for disaster endeavors. Dr. Gurung talked about the high relevancy of the theme Safe Hospital in Nepalese context.

Mr. Bishnu Bahadur Singh, Chairman, Mitra Kunj

mentioned that mutual collaboration is indispensable for comprehensive analyses of issues. Mr. Singh also stressed that it is the high time for the disaster management in Nepal.

Former Minister, Er. Ganesh Shah congratulated and thanked the organizing committee for organizing the workshop. He appreciated the gathering of experts to have interactive discussion in such an important subject matter. He also added that Climate Change is further increasing the vulnerability to mass casualty in the mountainous country like Nepal.

Dr. Govinda Kusum, Secretary (MoHA) and Chief Guest of the function explicitly said that geology is the indispensable discipline to be involved in the disaster management sector and thanked NGS for organizing this workshop. Dr. Kusum assured that necessary initiations are being taken in the disaster management sector from the government level. As an example of government's initiations, he mentioned that a team of experts has prepared the National Strategy for Disaster Management (NSDM 2009). Dr. Kusum highlighted main points of the NSDM. Those include the state of disaster risk of Nepal, evaluation of impact of disaster, policy regulation and their institutional management, strategic vision, sectoral strategies for disaster risk reduction, implementation and evaluation etc. Dr. Kusum asked all the development activists to analyze the interrelationship between disaster and poverty. The Chief Guest wished that the workshop would produce some pragmatic recommendations for the implementation of disaster management plan.

Mr. Jagadish Shrestha, Chairman of the session and President of Nepal Geological Society said that NGS is the pioneer professional society working and advocating the need of disaster management in Nepal. NGS's activities on disaster are extensive and acknowledgeable. He mentioned that NGS was awarded internationally by **Sasakawa Award** for its substantial contribution to scientific work in natural science and disaster management.

Mr. Shrestha expressed hope that this effort of NGS to bring the other concerned experts as doctors and psychologists at a single platform to discuss for the better management of casualty during an event of disaster would produce a substantial outcome both for policy and actions. On behalf of Nepal Geological Society, Mr. Shrestha thanked all the members of ISDR committee, doctors and participants for their participation in the thematic workshop.

TECHNICAL SESSION

The technical session was chaired by Mr. Pratap Singh Tater, Senior Hydrogeologist and the rapporteurs were Mr. Ashok Duwadi (Department of Mines and Geology) and Mr. Upendra Ratna Sthapit (Groundwater Resources Development Board). Four thematic papers were presented in the technical session, which is briefly summarized below:

1. Disaster preparedness management in hospital in Nepal: Dr. Parash Kumar Sharma, Director, Patan Hospital

Dr. Parash Kumar Sharma began his presentation with brief introduction over the different aspects of disaster management in hospitals such as planning, regular mock drilling, trainings to staff. Stating that Patan Hospital is pioneer institute in hospital disaster management, Dr. Sharma shared the experiences of Patan Hospital mentioning that it started the disaster management since 1984 from the Dasarath Stadium incident in which 70 people died from stamped.

Dr. Sharma explained the types of disasters as *Major* and *Minor* and necessary process of treatment for each type. Highlighting the importance of TRIAGE- *the action of immediate examination of patient and decide for appropriate treatment*- Dr. Sharma gave its detail process. Illustrating with a disaster plan map of Patan Hospital, he explained about the different priority zones marked with color: Red Zone-*needs immediate care*; Yellow zone-*not severe*; Green Zone-*Minor injuries*, and Black Zone-*allotted for dead patients*. Dr. Sharma then elucidated the different steps followed to treat the traumatic patients mainly dividing into two: Primary and Secondary survey. He then explained the management aspects as: team works, communication, roles and responsibility of all different section heads such as clinical director, supply director, communication director etc. Dr Sharma stressed that efficient chain of command from the security guard to disaster overseer (the ultimate authority) is essential.

Dr. Sharma illustrated the circumstances during the disaster with excellent pictures of mock drills of Patan Hospital that was carried out in 2008 and 2009. He finally concluded his deliberation appealing all the medical institutions to initiate the disaster management part with well-known saying "*Be prepared for today then you can manage tomorrow, it is never late to begin"*.

2. Relevancy of ISDR's theme, Nepal's strategy and challenges: Dr. Pradeep Vaidya, Professor, Institute of Medicine, Tribhuvan University

Professor Pradeep Vaidya covered two aspects, namely the strategic management of Hospital during disaster and Hospital Preparedness for emergency.

Dr. Vaidya started his presentation saying that the ISDR theme "Hospitals Safe from Disaster" highlights the necessity of disaster management in hospitals. He pointed out the different important aspects in hospital disaster management such as social value, economic impact, public health, medical care. Dr. Vaidya explained about the objectives of disaster management in hospitals that are categorized into *Structural and Nonstructural* Disaster

Management Plan. Emphasizing the training needs to policy makers, hospital staffs and government officials, he questioned to the concern authority- Where our National Strategy is?

Dr. Vaidya also discussed about the institutional initiation program on emergency preparedness- the HOPE-*Hospital Preparedness for Emergencies*. Emphasizing the need of integrated approach, he pointed out that HOPE is being carried out in collaboration of National Society for Earthquake (NSET), International Recourses Group (IRG), Johns Hopkins University Center for International Emergency, USAID and Institute of Medicine, Tribhuvan University. Dr Vaidya mentioned that the course aimed to assist health service providers, both administrative and medical, to enable them to prepare the facility and themselves to function effectively in a coordinated manner to respond to emergencies that involve large numbers of casualties. Showing some slides of thoughtful pictures illustrating the scenario of hospitals during the structural collapse from disasters; Dr. Vaidya informed the audience that the status of 14 major hospitals of the Kathmandu Valley is poor regarding the structural component.

Dr. Vaidya then explained and recommended that even the minor non-structural mismanagement could cause casualties, which otherwise could be avoided with minor efforts. Explaining the national strategy and achievement of HOPE, Dr. Vaidya concluded his presentation appealing "*Let us be prepared before disaster overwhelms us"*.

3. Importance of trauma counseling in disaster: Dr. Ganga Pathak, Associate Professor, Tribhuvan University and Chief Counselor- National Institute of Psychology

This paper discussed about the important aspect during

the disaster-the **Trauma counseling**. Dr. Ganga Pathak began her presentation from definition of trauma, general misconception over it with some appealing pictures of children in traumatic condition. Dr. Pathak gave details of symptom of traumatic patients, traumatic response patterns and discussed on how to help the victims. Dr. Pathak's discussion on how the traumatic patients behave and how the counselor could help them were very informative and drew the attention of all the participants. She emphasized to be careful on what we ***Should Say*** and ***Should Not Say*** to traumatic patients by the counselors. Dr. Pathak gave important list of tips. **"Do Say"** are: *these are normal reactions to a disaster, it is understandable that you feel this way, you are not going crazy, it wasn't your fault, you did the best you could, things may never be the same, but they will get better, and you will feel better*. Similarly, "**Don't Say"** includes: *it could have been worse, you can always get another pet/car/house, its best if you just stay busy, I know just how you feel, you need to get on with your life*. Dr. Pathak concluded her talk giving some guidelines for primary care to mentally disturbed people from the disaster chaos.

4. Early Warning System: Dr. Ranjan Kumar Dahal,
Lecturer,Tri-CHandra Campus Tribhuvan University

The fourth paper was more on technical aspects. Dr. Ranjan Kumar Dahal integrated his point of view under the headings: the landslide vulnerability of Nepal, discussion over casualties dominated by the rainfall triggered landslides, carelessness in the site selection of infrastructures including hospitals. Dr. Dahal presented some outstanding examples of overlooking the technical assessment of vulnerability in the construction of health centers and hospitals. He also emphasized that health centers outside Kathmandu are more susceptible to casualties from disasters. Dr. Dahal emphasized that landslide hazard mapping and early warning system of rainfall is very urgent and should be given priority. Dr. Dahal recapped his deliberation as: monsoon rainfall is the main trigger of landslides in Nepal, Nepalese concept of donors should be for low cost, the technologies need to be revised in the context of disaster, very few peoples are aware about disaster especially in the rural areas. He concluded his presentation saying substantial work is more important rather than awareness campaign organizing mass gathering and street rally.

WRAP UP SESSION

After the presentations, an intensive discussion took place among the presenters and audience about the different aspects of the presentations and disaster and mitigation in general. Various queries from the audiences were answered by the presentations. After the discussions a list of general inferences and recommendations were drawn and passed by the workshop.

Session Chairman Mr. Pratap Singh Tater wrapped up the session summarizing the essences of each four papers categorically. Mr. Tater expressed that he himself learnt many things from the presentations and discussions about the disaster management and hoped that all the participants have the similar feelings.

Mr. Tater said that the initiation of Patan Hospital is highly appreciable and he congratulated Patan Hospital being the pioneer in practicing the disaster management system. He stressed the need of general public awareness about disaster and its preparedness. He said that all the staffs of medical centers and hospitals should undergo the HOPE course.

Mr. Tater realized that in our common practice of counseling to victims, we normally use to say what is not recommended by the expert. He appealed all to follow the expert recommendations while counseling, otherwise it could have adverse consequence. Mr. Chairman agreed that there is lack of proper technical consideration during the site selection and construction of hospital buildings. He said all technicians should be serious on the professional ethics while designing, implementing and monitoring structures.

Finally, Mr. Tater concluded that the workshop is a success as it could extract the substantial outcomes over the announced theme "Safe Hospital from Disaster". Thanking to the organizing committee and the Nepal Geological Society, and all resource persons and participants, he ended the technical session. With the permission of Chairman, Dr. Pathak, General Secretary of theSociety, thanked all the experts, professionals and

participants for their presence and announced the closing of the half day workshop.

GENERAL INFERENCES AND RECOMMENDATIONS

- There is high uncertainty in the safe hospitals and disaster preparedness throughout Nepal
- Only few large hospitals in the Kathmandu Valley has acquired disaster management systems though carried out in personal initiatives
- There is high time of national strategy and guidelines to deal with disasters in Nepal
- There is big gap of knowledge and information among the different organizations who are taking initiatives in disaster management
- There is urgent need of standard protocols of development activities including infrastructures and their effective implementations
- Activities for awareness activities for public to professional is indispensable for better management of disaster
- Substantial work is more essential for disaster management in addition to awareness campaign organizing mass gathering and street rally.

OUTCOME

- National status & strategy concerning the disaster management were known to experts, professionals and policy makers who participated in the workshop
- This workshop helped to strengthen better networking among the different actors functioning in the disaster management such as geologists, urban planners, engineers, medical practitioner etc.
- Pragmatic recommendations to concern entities and individual working in the disaster management have come out from the discussion.

ABSTRACTS OF PAPERS PRESENTED IN WORKSHOP ON INTERNATIONAL DAY FOR DISASTER REDUCTION: HOSPITALS SAFE FROM DISASTERS
On the occasion of ISDR Day-2009

Role of HOPE in making safe hospitals

Pradeep Vaidya
Tribhuvan University Teaching Hospital, Kathamandu, Nepal

Most of the disaster in the world occurs in the South East Asia. With all this experience, one would expect a disaster management course from this region, but most of the disaster trainings are the imported ones from the West. This was the reason the Hospital Preparedness for Emergencies (HOPE) was developed. This course was developed by the experts of the region and was implemented for five years successfully in six South East Asian countries. As the countries involved were all earthquake prone, the course was mostly earthquake centric. In February 2008, four regional experts were again given the task to modify and redevelop the HOPE into a multi hazard course. This was successfully done and it was piloted in Nepal and was successfully implemented in four countries Bangladesh, Philippines, Pakistan and Nepal.

The Hospital Preparedness for Emergencies (HOPE) Course is a four-day course of the Program for Enhancement of Emergency Response that was developed by the United States Agency for International Development through its Office of U.S. Foreign Disaster Assistance together in collaboration with Johns Hopkins University, Asia Disaster Preparedness Center, National Society for Earthquake Technology-Nepal. The course has been tested and delivered in Thailand, Indonesia, Nepal, Philippines, Bangladesh, India and Pakistan. It addresses the structural, non-structural, onsite and inpatient management of disasters including planed evacuation from the hospital if required.

The result of HOPE is that we have developed enough instructors for the course so that we can conduct it locally. Second, HOPE has trained most of the staff of various hospitals, regional and central hospitals and the result is that there is more interest in making their disaster plans, of doing drills.

Finally the most important reason for this course is to help hospitals prepare for emergencies. Before Hope, only some of the hospitals had disaster plans which were stored and not used. Only one hospital in Kathmandu valley had drills regularly. Now, with more than 150 HOPE graduates from 15 hospitals in and out of Kathmandu, we have twelve hospitals which are in the process of developing a working disaster plan and some have also conducted drills. Seven hospitals are preparing their disaster plans including three private hospitals after which they are planning to do the drill.

The future goal is to make all the big hospitals of Kathmandu and the district hospitals of Nepal into a HOPE certified hospitals. Hopefully, if nothing else is done to prepare for the disaster by the countries due to their limitations or their priorities, at least, the hospitals can be prepared while waiting for the disaster to occur.

Disaster management at hospital

Paras Kumar Acharya
Patan Hospital, Lalitpur, Nepal

To bring chaos into order and to present unnecessary morbidity and mortality in hospital during the disaster period, there should be done disaster management plan, regular moch drills and training in trauma care in the hospital. There should be identified as minor disaster (less than 20 victims, managed within ER, extra help called in by receptionist, way develop into major disaster, if 15 or more serious) and major disaster (more than 20 victims). In case of major disaster, there should be announced decision to declare disaster state made by

consultant, nursing supervisor or senior administrator present in the hospital at the time, siren goes off and then disaster plan will be activated.

From trauma management, there should be done as primary survey (airway and spine, breathing, circulation, disability and exposure) and secondary survey. Therefore, to mange disaster in a systematic way in hospital, it should be prepared for today, then it can be managed for tomorrow. It is never late to begin.

Importance of trauma counseling in disaster

Ganga Pathak
National Institute of Psychology, New Baneshwor, Kathmandu, Nepal

A disaster is a sudden, overwhelming, totally unexpected and unforeseeable event that may be accompanied by multiple deaths, injuries, loss of property and destruction of daily life. Disaster may be natural or man-made. Disaster create sever impact on human psychology. The impact cause major psycho-social and emotional distress to a person and that is called trauma. People often show horrifying reactions like paralyzing anxiety, uncontrolled fight- behavior, and group panic on this stage. Sometimes these reactions may convert into severe psychiatric disorders.

Trauma may be physical and psychological or both may occur together. For some people the experience of trauma can destroy whole normal personality and hinders normal life. It develops typical responses pattern in physical, affective, cognitive and behavioral aspects. We can help traumatized people to return to normal life by various ways and among them the best effective way is to provide them psycho-social and trauma counseling.

Trauma counseling helps the victims providing psycho-social and emotional support to normalize distressed feelings and reactions. It helps to adapt coping skills and prevents future mental health issues.

Landslide hazard mapping and early warning system for Nepal

***Ranjan Kumar Dahal**
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The mountain slopes are very vulnerable to landslides. So, landslide hazard assessment needs to be considered as main component during planning of developmental projects on mountain slopes. The potential sites that are particularly prone to landslides should be identified in advance to reduce damages on infrastructures. This presentation exclusively describes science of landslide hazard mapping and its use in engineering and planning level. Statistical landslide hazard mapping procedures are described in this presentation with some case studies. Conceiving recent strategies of development of Nepal and encouraging from accuracy of the zonation maps, a proto-type landslide hazard map is proposed for use in village communities of Nepal, which will certainly help to reduce landslides calamities in villages and cities of Himalayan mountain slopes.

The increasing number of the temporal recurrence of landslides shows that disastrous events occur with a frequency higher than the social and economical ability of a country to recover from previous events. Both developed and developing countries are less easer to invest in mitigation measures owing to the huge cost and direct impact on functional development of the country. As a result, many countries are now interested to develop early warning system as well as land utilization regulations for minimizing the loss of lives and property damage without investing in mitigation measures.

Developed countries like, USA, Japan and many European countries have already developed well-equipped and sophisticated early warning system for almost all kinds of natural hazard. They have also developed rainfall-induced landslide early warning system and they are now capable to reduce death toll in the minimum level even in the very worse typhoon or hurricane events. Adversely, a developing country like Nepal still does not have any such concept and every year more than 300 people died by natural hazards.

With application of early warning system, the death toll could be reduced in the minimum level. The identification of regional thresholds for the initiation of landslides plays a strong role in helping mitigating geological and hydrological risk. When a rainfall is expected, monitoring meteorological, hydrological or geotechnical parameters, such as rainfall intensity-duration, river discharge or groundwater pore pressure, coupled with initiation thresholds and landslide hazard zonation defined either in statistical or deterministic fashion, may allow for the identification of potentially hazardous conditions and to issue warning message to civil protection authorities and community. Therefore, in this presentation, rainfall threshold of landslide for the Nepal Himalaya are used to prepare a proto-type landslide early warning system coupling with landslide hazard map. Taking reference of the intensity-duration threshold and normalized rainfall intensity threshold, two proto-type models of early warning systems (RIEWS and N-RIEWS) are proposed in this presentation. The proposed model is believed to be an economical and most suitable model to initiate early warning system of rainfall-induced landslide in Nepal.

ABSTRACTS OF PAPERS PRESENTED IN THE SCIENTIFIC TALK PROGRAMMES

Disappearing glaciers of Himalaya and Tibet in the context of global warming

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Most mountain glaciers worldwide are retreating. Glaciers have been retreating worldwide since the end of the Little Ice Age (around 1850 A.D.), but in recent decades they have begun melting at very high rates. They are the Earth's largest freshwater reservoir, and form the lifeline or source of many of the world's major rivers including the Himalayan rivers. Projected climate change over the next century will further affect the rate at which glaciers melt. Average global temperatures are expected to rise 1.4-5.8 ^{0}C by the end of the 21st century (Third Assessment Report from the Intergovernmental Panel on Climate Change (IPCC, 2001). Simulations project that a 4ºC rise in temperature would eliminate nearly all of the world's glaciers.

The vast majority of glaciers in Asia have been retreating and thinning over the past 30 years, with accelerated losses in the last decade. In the northern Tien Shan (Kazakhstan), glaciers have been collectively losing 2 sq. km of ice (0.7 % of their total mass) per year since 1955. Glaciers in the Ak-shirak Range of Kyrgyzstan) have lost 23% of their area since 1977, and similar losses in the northern Tien Shan (29% from 1955-1990) and the Pamirs (16% from 1957-1980). The Chinese Meteorological Administration predicts that China's northwestern mountains will lose over a quarter of their current glacier coverage by 2050. The last ten years have shown the greatest warming in the Tibetan Plateau. In the past 40 years or more, glaciers have shrunk more than 6,606 km^2 in the entire Tibetan Plateau, with the greatest retreat occurring since the mid 1980s.

Tibetan Plateau together with the Himalayan region is the most concentrated glacier center outside the polar caps. With glacier coverage of 33 to 34,000 km^2, the region is aptly called the "Water Tower of Asia" as it provides around 8.6 X 10^6 m^3 of water annually. There are about 15,000 glaciers in the Himalaya. These "Water Towers of Asia" contribute crucially to the water supply of hundreds millions of people during dry season, feeding seven of Asia's great rivers: the Ganga, Indus, Brahmaputra, Salween, Mekong, Yangtze and Huang Ho in which basins more than 1.3 billion people find their livelihoods. But they are suddenly melting so fast that they are drying up. Sixty-seven percent of glaciers are retreating at a startling rate in the Himalayas. Glaciers in the Himalaya are receding faster than in any other part of the world (IPCC, 2001). Himalayan glaciers are retreating at rates ranging from 10 to 60 m per year, and retreat rates of 30 m per year are common. Many small glaciers (<0.2 sq. km) have already disappeared. Vertical shifts as great as 100 m have been recorded during the last fifty years. The Himalayan glaciers can be considered as a reliable indicator of climate change. Studies show that the terminus of most of the high altitude valley glaciers in Bhutan, China, and Nepal are retreating very fast. Warming in the Himalayan region has been much greater than global average. This phenomenon is causing concern over the long term reduction in total water supply, affecting lives and livelihoods of the Himalayan people, especially in agriculture practices and long term food security. In the Ganga, the loss of glacier meltwater would reduce July-September flows by two-thirds. It is estimated that the rapid melting of Himalayan glaciers will first increase the volume of water in rivers causing widespread flooding but in a few decades this situation will change and the water level in rivers will decline, meaning massive economic and environmental problems.

Climate change has tremendously impacted the glacier ecosystem in the Nepalese Himalayas. For developing countries like Nepal, climate change is not just an environmental phenomenon but also the economic, social and political issues. Nepal is among the most vulnerable countries on earth with regard to climate change. Climate change is a pressing issue and a growing concern to Nepal as all-Nepal temperature (maximum mean) since 1977 has raised 0.9 ^{0}C, at a rate between 0.03 °C yr^{-1} and 0.12 ^{0}C yr^{-1}, with an average of 0.06 ^{0}C yr^{-1}, whereas the global average surface temperature rise of the last century was only 0.6±0.2 ^{0}C. The observed underlying trend of rising temperature in Nepal is challenging the IPCC projection as it seems that land areas will warm more rapidly than the global average.

Associated with the temperature change, monsoon precipitation has undergone some changes with decreasing rainy days and increasing high-intensity rainfall events, resulting into increase in magnitude and frequency of water-induced disasters - landslides, debris flows and floods. Glaciers are retreating as high as 100 m/yr, eliminating many small glaciers, creating new and enlarging the existing glacial lakes. Breaching of some of the lakes have already resulted into seven major Glacier Lake Outburst Flood (GLOF) events in the past 30 years, and the 26 glacial lakes (out of the 2315 lakes in Nepal) are reported to be potentially dangerous for GLOF. Almost 20% of the glaciated areas in Nepal above 5000 m are likely to be snow and glacier free area at an increase of air temperature by 1 ^{0}C. The depletion in the water resources (projected) is likely to be seriously affecting the hydropower potential, irrigation, and even the drinking water supply in the country and the region. The recent study in Langtang valley shows a consistent trend of increase of temperature since late 1980s that has resulted in the fast melting of glaciers and their retreat both horizontally and vertically. On analyzing and comparing the satellite images of 1979, 1989, 1999 and 2009, it is found that there are distinct changes in the snout positions of the glaciers. This is a serious concern not only for the tourism industry of Nepal as lots of tourists come to Nepal to see the snow capped mountains and glaciers; but it is a highly disturbing scenario which points to a serious consequences in the future in the fields of water resources, agriculture and biodiversity. Climate change is also expected to bring increased natural hazards such as floods and famines, landslides and debris flows.

The present study shows that in the Kyanjing Gumba area, the higher part of the Langtang valley, the yearly temperature data shows a consistent rising trend since 1988, a clear indication of global warming. However, the temperature data from the lower altitude at Dhunche station shows much subdued rising trend indicating that higher altitudes are much more sensitive to temperature increase than at lower altitudes due to global warming. The hydrological study shows that despite the decreasing trend of annual precipitation, the discharge of the Langtang River is showing an increasing trend of discharge. This can be possible only due to the increased rate of melting of the glaciers at higher altitudes.

The interpretation of satellite imageries of the valley very clearly shows horizontal retreat of most of the glacial snouts and in the last 30 years (between 1979 and 2009) some of them have retreated or shrunk for over 900 m with an average retreat of about 30 m/year. Similarly some of glaciers have retreated over 100 m vertically in the last 30 years. Comparison of the aerial extent of the glaciers in the Langtang Valley between 1979 and 2009.. Langtang Lirung Glacial coverage area has shrunk by 62% in the last 30 years. If this rate continues, this glacier might just melt away within another one or two decades. The total loss of glacial overage area of the entire Langtang watershed within the last 30 years is 24%.

Sedimentology and basin analysis of the Thakkhola-Mustang Graben, central Nepal

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The Thakkhola-Mustang Graben, which reflects Neogene extensional tectonics in the Tibetan Plateau and Himalaya, lies north of the Dhaulagiri-Annapurna ranges and south of the Yarlung-Tsangpo Suture Zone. The basement to the graben comprises Tibetan-Tethyan sedimentary rocks of Paleozoic and Mesozoic ages, unconformably overlain by continental, mainly coarse-grained deposits (more than 850 m thick) of Neogene to Quaternary age. Stratigraphically, the Thakkhola-Mustang Graben sediments have been divided into five formations, namely, from the base upwards, the Tetang, Thakkhola, Sammargaon, Marpha and Kaligandaki formations. The Miocene Tetang and Thakkhola formations are disconformably overlain by the Plio-Pleistocene Sammargaon and Marpha formations. The Kaligandaki Formation, of Holocene age, has a cut-and-fill relationship with the underlying Marpha Formation. The Thakkhola and Tetang formations are separated by a low-angle (~5°) unconformity. Previous researchers studied the basement geology and stratigraphy of the Neogene sediments. However, Neogene paleoclimatic conditions, sediment provenance and the depositional environment(s) of the Neogene sediments have not been investigated in detail previously.

To address these problems, detailed field mapping was undertaken on both sides of the Kali gandaki River, in conjunction with lithostratigraphic and sedimentological logging of 22 profiles and measuring imbricate pebble orientations. Heavy mineral analyses (50 samples), stable isotope and thin-section analyses of carbonate rocks, palynological investigations (30 samples), compositional analyses of sediments and petrographic studies of sandstones for provenance analysis were also carried out. Facies analysis was done by studying vertical and lateral sedimentary variations within the basin. Provenance analysis was carried out by analyzing heavy minerals, paleocurrent analysis and bulk mineralogical analysis (using X-ray diffraction and sandstone petrography). The Neogene paleoclimate was inferred from oxygen and carbon stable isotopes from carbonate lithologies and from palynological data.

In the study area, 12 different lithofacies were found in three lithofacies associations. The associations are (1) matrix-rich conglomerate-gravelly sandstone association, (2) matrix-rich conglomerate with sandstone and mudstone and (3) massive siltstone with mudstone, alternating with carbonate layers. The investigation revealed that the sediments were deposited in alluvial fan, lacustrine, braided river and glacio-fluvial environments. Small braided river systems were dominant in the initial depositional phase of the Tetang Formation whereas a lacustrine environment was widespread in a later stage. Braided fluvial deposits and lacustrine deposits at different levels of the sedimentary succession dominate the Thakkhola Formation. The Sammargaon Formation is associated with glacial tills. The Marpha Formation is interpreted as glacio-lacustrine deposits. The Kaligandaki Formation was deposited in a fluvial environment.

The paleocurrent data of imbricate pebbles from all formations of the basin show a generally southward flow direction. At Dhi and Tange, the Thakkhola Formation consists of clasts derived mainly from the Mesozoic rock exposed to the east. In the Ghiling, Dhakmar and Chaile areas, the Thakkhola Formation is represented by the clasts of Paleozoic, Mesozoic and Tertiary rocks. They indicate the paleoflow from the north and west. The conglomerates of the Tetang Formation comprise mostly Mesozoic rocks with an easterly provenance. Minerals from low-to high-grade metamorphic sources are reflected in the heavy mineral assemblages of the Neogene deposits. Bulk compositional analysis of the sediments of the Thakkhola-Mustang Graben reflect the presence of quartz, calcite, muscovite, and chlorite with minor amounts of halite and clay minerals in some samples. Sandstones of the Thakkhola Formation are characterized by a high amount of quartz, low feldspar contents and low to moderate amounts of unstable lithic grains. Polycrystalline quartz with metamorphic rock fragments in lithic grains indicate a granitic source as well as sedimentary and low-grade metamorphic source terrains.

Pelletal, charophytic algae and oncolitic algal micritic limestones are present in the Thakkhola Formation. In the Tetang Formation micritic limestone with ostracods, micritic mudstone with roots and oncolites have been found. There appear also sporadic quartz clasts in the limestone. These features suggest that these limestones were developed in a lacustrine environment a considerable distance away from the river-mouth. Ostracods in dark micritic limestone indicate quite and calm water conditions. Although a very thick (850 m) pile of sediments was deposited in the Thakkhola-Mustang Graben, limestone microfabrices indicate a flat shallow lacustrine environment. The delta^{18}O values of the limestones from the Thakkhola-Mustang Graben are very similar to those obtained from the recent meteoric water analyzed by previous researchers from the area, indicating that the Thakkhola-Mustang Graben attained its current elevation prior to east-west tectonic extension of the Himalaya. The relatively high delta^{3}C values of the carbonates suggest that the Himalaya existed as an orthographic barrier to moisture already during the Miocene period.

A palynological study shows that the sediments of Tetang and Thakkhola formations (Miocene-Pliocene) contain pollen of dominantly alpine trees such as *Pinus, Picea, Tsuga* and *Quercus,* with some steppe elements such as *Artemisia*, Compositae, Chenopodiaceae, *Plantago* and Poaceae. These indicate a dry climate during sediment deposition. Consequently, it is presumed that the paleoclimate during the evolution of the Thakkhola-Mustang Graben was significantly warmer than the present-day climate.

Numerical modeling of continental extension to collision: Examples from the Red Sea, Gulf of Suez and Anatolia

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This research carried out in the Department of Physics and Earth Science, University of the Ryukyus, Okinawa, Japan summarizes three separate works where numerical modeling has been applied to investigate rheological structure and analyzing possible state of stress and deformation in the Red Sea, Gulf of Suez and Anatolia using FE software package (Hayashi 2008). Numerical approach includes plane strain modeling for the Red Sea and plane stress modeling for the Gulf of Suez and Anatolia. The study area forms a vast and complex geodynamic setting that is largely governed by the relative movement of northward moving African and Arabian plates with extension in the south to collision in the north. It is an excellent area to study active tectonics and ongoing deformation in the

lithosphere. The structural models investigated by using the FE software package provide useful information about distribution of the stresses and their condition, as well as possible areas of deformation which are, in fact, helpful in understanding the occurrence of the faults and earthquakes. Modeling results demonstrated that the physical property of rock layer and boundary conditions formed by the regional plate kinematics are very important and essential parameters that control the stress field and deformation pattern in the region. Stress data from World Stress Map (WSM) project and Global Positioning System (GPS) data are used as proxy for the verification of modeling results. Fault plane solutions, on the other hand, provide important information about the tectonic setting and focal depth data are extremely valuable in understanding regional stress field as well. The correlation between measured or observed stress data, structural fabrics, active faults and earthquake focal mechanisms, in general, showed that brittle fracture is the relevant mechanism in generating contemporary stress field, earthquakes and active faults in the region.

ARTICLES

Impact of climate change on discharge characteristics of the Narayani River, Nepal

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ABSTRACT

The Himalayan rivers are considered to be very vulnerable to climate change because water source in most rivers depends on discharge from snow and glacier melt and makes a substantial contribution to the runoff. The rise in temperature in high mountainous region has caused rapid melting of glacier ice and the effect is manifested in most of the snow-fed rivers of Nepal. The discharge data of Narayani River for years 1963-2006 and the precipitation data from Rampur meteorological station (Chitwan) for years 1971-2006 as well as several other rainfall stations within Narayani River basin for years 1999-2007 were used for the analysis. Data of pre-monsoon discharge and precipitation were analyzed to draw inference about impact of climate change on hydrological regime of the Narayani River. The general trends of discharge for the pre-monsoon period show a positive increase in discharge rate, while the precipitation record of several stations for the pre-monsoon period shows decreasing trend. The increasing trend of discharge of the Narayani River can be attributed to melting of ice in the source region. The increasing discharge in major rivers are likely to be a matter of concern to water managers to assure safeguard lives and properties from increased floods in wet seasons and most importantly the country's gross hydropower potential. Further, climate change has significant impact on Nepalese economy.

Keywords: Climate change, rainfall, discharge, Narayani River

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INTRODUCTION

The Himalayan range comprises the largest mass of glaciers outside the Polar regions and plays key role in hydrological regime of the South-Asian major rivers. The range acts as an important storage of water, playing important role for bio-diversity, agriculture and hydropower, and serving habitat for more than 1.3 billion people in the downstream basin areas (Eriksson et al. 2009). The hydrological regimes of Himalayan rivers are regulated by accumulation of snow and ice and the rate of melting. Climate change, especially global warming, can cause dramatic impact in hydrological regime. The annual warming in the Himalayan region between 1977 and 1994 was 0.06 °C (Shrestha et al. 1999). The increase in global mean temperatures over the next one hundred years could range from 1.4 to 5.8 °C (IPCC 2001). Increased annual average temperature increases thawing of ice including glacier ice calving; glaciers of the Himalayas are retreating (Bajracharya et al. 2007). The phenomenon leads to increase in annual discharge in the rivers.

Climate change has direct impacts on rainfall and snowfall patterns (Chaulagain 2009). Extreme events like floods, storms and droughts etc. have been increasing in the region. Consequently, hazards induced by climate change have serious impacts in human lives, agriculture, hydropower and the whole ecosystem of the region. Analysis of data on precipitation is imperative to understand discharge characteristics of the Himalayan rivers.

STUDY AREA

The study area includes the Narayani River Basin that lies in central and western Nepal (Fig. 1). The basin extends from 27º 15' to 29º15'N and from 83º00' to 85º45' E. Trishuli, Burhi Gandaki, Marshyangdi, Seti and Kali Gandaki are the major tributaries of the Narayani River.

All the major tributaries are snow-fed and originate from Higher Himalayan and Trans-Himalayan regions. The Narayani River drains 42,480 km^2 at the gauging station located in Narayanghat at downstream from the confluence of Kali Gandaki and Trishuli rivers. Elevation of the basin varies from 150 to 8164 m with average elevation of 3100 m.

The spatial variation of annual rainfall is high with total annual precipitation ranging from 100 mm in Jomsom to 4880 mm in Pokhara. The annual variations of rainfall show that about 75% of the rainfall occurs during three months

: July, August and September (Kharbuja and Sharma 2008). The Narayani River has been gauged since 1963. Based on the records from 1963 to 2006, the average annual daily flow of Narayani River is 1580 m^3/sec. (DHM 2007).

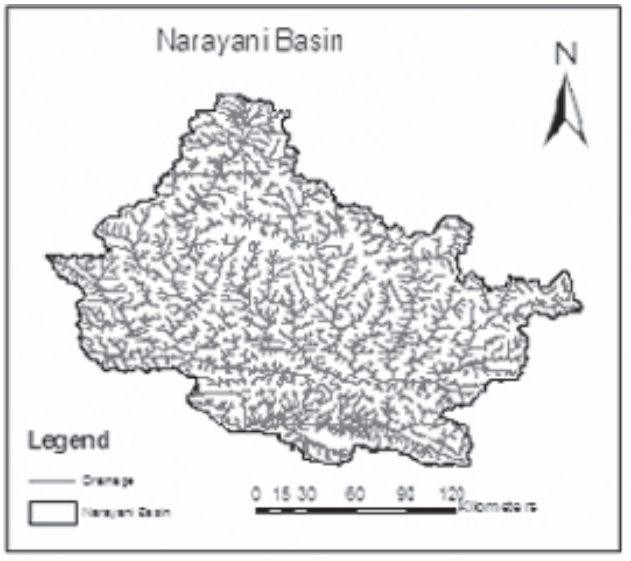

Fig. 1: The Narayani Basin lying in central and western Nepal

DATA ACQUISITION AND ANALYSIS

The study has been performed using discharge and precipitation data. Discharge data is obtained from meteorological station at Narayanghat (Station No. 450) for the analysis. Monthly and annual discharge data from 1963 to 2006 is shown in Table 1. Precipitation data of the stations within Narayani catchments: Garakot, Pokhara, Bandipur, Malepatan, Khairenitar, Damauli, Rumjakot from 1999 to 2007 is shown in Table 2. Similarly, the precipitation data of Rampur station for years 1971 to 2006 is given in Table 3. For the present study, analyses have been focused on pre-monsoon (February, March, April, and May) discharge and precipitation data (Tables 2 and 3).

RESULTS AND DISCUSSION

Fig. 2 and Table 4 show cumulative monthly average discharge of pre-monsoon record of the Narayani River during 1963–2006. The maximum value occurred in 1989 i.e. 2321 $m^3 s^{-1}$ and the minimum occurred in 1970 i.e., 1026 $m^3 s^{-1}$. Similarly, Fig. 3 and Table 4 show the average minimum of annual discharge occurred in 1970 i.e. 187 $m^3 s^{-1}$. During the monsoon and post-monsoon period, the discharge augments not only by accelerated glacier melting but also by increased precipitation and ground water flow.

The hydrograph in Fig. 2 shows slight change in discharge however, the annual variation is very large. Although, statistically insignificant, the linear regression line depicts slight positive increase in the pre-monsoon discharge with the rate of 4.3 cumecs/year.

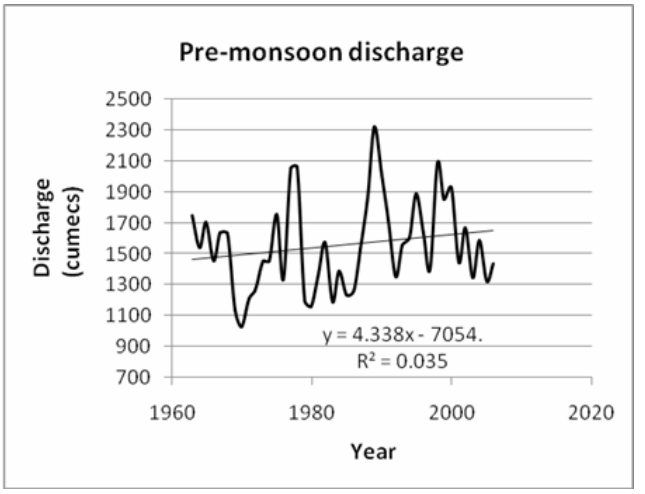

Fig. 2: Hydrograph showing changes in cumulative monthly average discharge of pre-monsoon record of the Narayani River during 1963-2006

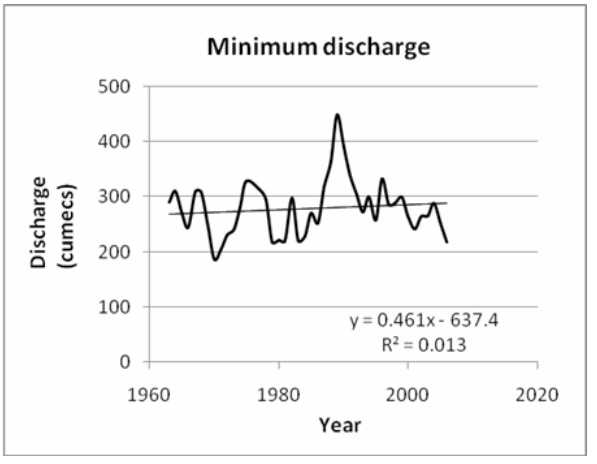

Fig. 3: Hydrograph showing changes in average minimum annual discharge of the Narayani River during 1963-2006

The minimum annual discharge for pre-monsoon period is shown in Fig. 3. The regression line also shows very slight positive increase in the discharge rate. The graph of annual precipitation at the Rampur station during 1971 to 2006 shows increasing trend, though there is significant inter-annual variations (Fig. 4). The plot of rainfall data for other stations located upstream from the river level gauging station at Narayanghat for the recent years (1999-2007) shows negative trend (Figs. 5, 6 and 7). The result signifies

Table 1 ; Average monthly discharge of Narayani River for years 1963-2006 (DHM-2007)

Average Monthly Discharges (Cumecs)												
Station Name : Narayanghat											Elev. :180msl	
Station No: 450											Lat. :27º42'30''	
River : Narayani											Long.: 84º25'50"	
	Months											
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1963	462	351	290	408	699	1690	3760	5160	3720	1700	1070	820
1964	453	377	310	413	444	1180	4060	4610	3570	1760	987	638
1965	472	323	268	470	642	1520	3130	4610	2820	1310	954	592
1966	369	313	245	285	615	1330	3490	5330	3380	1320	852	583
1967	431	328	309	422	578	1400	3800	4060	2990	1390	806	541
1968	407	308	320	366	636	1920	4470	4180	3150	2820	1040	670
1969	315	250	245	262	380	1000	2890	4060	3580	1200	569	341
1970	249	208	187	257	374	1610	5150	5420	2540	1320	604	360
1971	263	213	205	309	479	2720	4270	4930	2690	1730	862	427
1972	315	257	231	236	546	1280	4880	4100	2810	1170	664	377
1973	295	241	254	351	608	2090	2960	4770	4070	3430	988	545
1974	404	317	281	368	492	1110	4110	6420	2990	1480	800	521
1975	430	386	328	402	638	3340	5040	4500	4940	1840	905	566
1976		346	330	354	306							
1977	374	336	314	594	808	1500	4520	8530	2850	1120	695	434
1978	349	295	304	422	1040	2470	5840	5840	2990	1590	711	425
1979	303	262	218	283	435	977	3600	5070	2430	1130	571	395
1980	273	223	222	281	435	1610	4740	5340	4060	1270	629	382
1981	286	240	221	345	567	1350	4700	5400	3400	1440	708	418
1982	325	298	325	437	514	1620	3490	4860	3300	1070	602	382
1983	283	235	221	230	505	863	3170	4130	4490	1930	823	457
1984	344	255	229	238	669	1820	5740	4190	4660	1240	639	424
1985	320	271	278	289	397	1070	4780	3910	3890	1840	894	515
1986	367	287	253	319	402	2010	4620	3810	4670	1630	818	545
1987	395	337	317	390	488	1330	5500	5630	2930	1410	875	587
1988	430	372	365	441	694	1450	5280	7460	3600	1350	793	595
1989	576	459	449	484	929	1850	4360	6190	3330	1500	805	546
1990	433	390	395	483	743	1900	5370	4580	3010	1460	769	511
1991	421	345	340	379	659	1610	3400	5250	3960	1240	656	460
1992	385	328	303	317	409	931	2150	4860	2670	1270	669	441
1993	349	316	273	344	623	1310	2990	5880	3870	1530	772	470
1994	363	307	300	350	651	1920	3320	4140	3090	1260	612	392
1995	304	258	267	323	1040	3220	5010	4500	2730	1400	875	486
1996	376	338	335	333	627	1710	4240	5280	3500	1750	820	481
1997	361	294	286	346	475	1310	4000	3770	2420	1120	639	609
1998	368	288	304	433	1060	2090	5220	6630	3680	1800	890	569
1999	435	343	300	397	814	2040	4690	5270	3840	2120	992	644
2000	458	354	265	390	919	2980	4460	5430	4050	1420	766	464
2001	355	305	242	277	619	2100	3890	5490	3540	1470	776	506
2002	347	288	264	358	757	1640	4520	4710	2460	1170	604	393
2003	299	307	266	337	439	1520	4970	4640	3990	1430	751	491
2004	377	294	289	359	646	1670	3920	3980	2990	1630	724	464
2005	360	277	251	290	508	1030	3600	4090	2120	1280	726	410
2006	293	248	219	255	714	1530	3390	3180	2690	1080	556	369

Table 2: Cumulative of pre-monsoon precipitation at seven stations for years 1999-2007 (DHM 2007)

Year	Pre-monsoon precipitation (mm)						
	Garakot	Pokhara	Bandipur	Malepatan	Khairenitar	Damauli	Rumjakot
1999	239.4	942.9	188.7	815	690.1	573.3	347.1
2000	456.1	947.2	545	824.4	736.3	672.3	490.1
2001	337.3	511.2	321.7	396.9	554.9	393.7	508.2
2002	436.6	755.1	443.6	654.3	576.1	403	555.7
2003	207.5	633.2	287.5	506.7	298.4	408.6	348.4
2004	274.4	737.5	394.3	558	451.5	469.6	289.7
2005	164.3	510.8	333.8	391.4	411.8	385.8	298.3
2006	335.6	822.5	315.8	751.2	678.2	412.4	557.8
2007	346.5	747.3	475.2	669.5	214.7	358.4	370.1

Table 3: Cumulative pre-monsoon precipitation (February + March + April + May) at Rampur Station for years 1971-2006 (DHM 2007)

Year	Cummulative Pre-monsoon Precipitation (mm)	Year	Cummulative Pre-monsoon Precipitation (mm)	Year	Cummulative Pre-monsoon Precipitation (mm)
1971	279	1983	204	1995	217.7
1972	144	1984	320	1996	160
1973	214	1985	218	1997	232.4
1974	194	1986	150	1998	338.8
1975	174	1987	186.2	1999	344.3
1976	225	1988	353.5	2000	423.5
1977	279	1989	190.3	2001	333.7
1978	363	1990	222.5	2002	523.5
1979	48	1991	167	2003	322.3
1980	202	1992	101.1	2004	291.6
1981	412	1993	331.5	2005	207.6
1982	160	1994	190.1	2006	408.7

less contribution of precipitation to the discharge of major rivers.

CONCLUSIONS

The influence of increasing glacier melting is manifested in the hydrological regime of the snow-fed rivers. The immediate impact period is the period of accelerated discharge rate followed by an episode of decreasing discharge. The increase in temperature in the mountainous region accelerates the melting of ice with subsequent increase in discharge of major rivers. During the monsoon period, higher temperature hinders formation of snow and thus the accumulated water in the mountainous region rapidly flows downwards causing extreme floods and extensive erosion.The change in discharge rate could be related to the climate change.

Over-draining and siltation of large part of agricultural land by flash floods threat to food security is another adverse problem. The sediments carried by the rivers may cause negative impact to hydropower structures as well.

The study has been conducted in the absence of statistically significant precipitation data. Hence, more detail analysis has to be done using realistic datasets and the result has to be well correlated to precipitation data that will represent precipitation over source area of the Narayani River Basin.

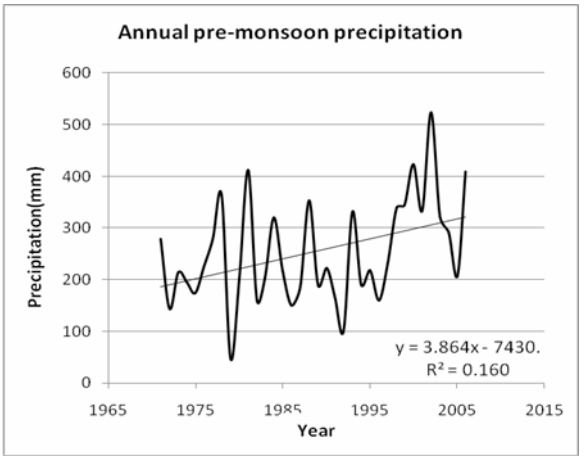

Fig. 4: Graph showing linear trend of pre-monsoon precipitation at Rampur Station for years 1971 - 2006

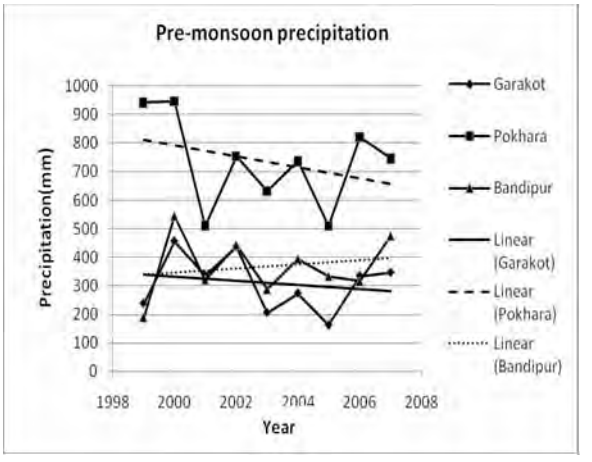

Fig. 5: Pre-monsoon precipitation changes at stations Garakot, Pokhara, Bandipur during 1999-2007

Table 4: Cumulative of monthly average discharge of pre-monsoon record and minimum annual discharge of Narayani River for years 1963-2006 (DHM 2007)

Year	Cummulative Pre-monsoon Discharge Feb+Mar+Apr+May (Cumecs)	Minimum Annual Discharge (Cumecs)	Year	Cummulative Pre-monsoon Discharge Feb+Mar+Apr+May (Cumecs)	Minimum Annual Discharge (Cumecs)
1963	1748	290	1985	1235	271
1964	1544	310	1986	1261	253
1965	1703	268	1987	1532	317
1966	1458	245	1988	1872	365
1967	1637	309	1989	2321	449
1968	1630	308	1990	2011	390
1969	1137	245	1991	1723	340
1970	1026	187	1992	1357	303
1971	1206	205	1993	1556	273
1972	1270	231	1994	1608	300
1973	1454	241	1995	1888	258
1974	1458	281	1996	1633	333
1975	1754	328	1997	1401	286
1976	1336	306	1998	2085	288
1977	2052	314	1999	1854	300
1978	2061	295	2000	1928	265
1979	1198	218	2001	1443	242
1980	1161	222	2002	1667	264
1981	1373	221	2003	1349	266
1982	1574	298	2004	1588	289
1983	1191	221	2005	1326	251
1984	1391	229	2006	1436	219

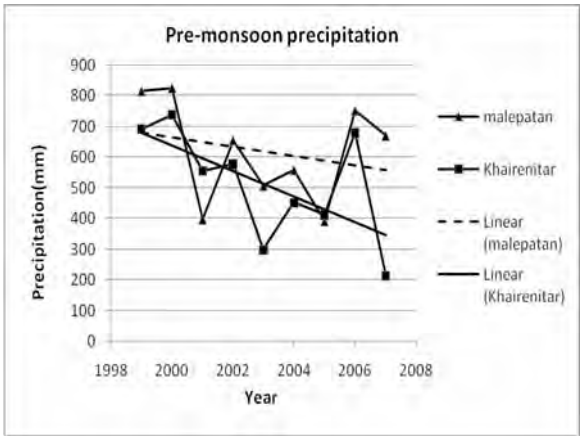

Fig. 6: Pre-monsoon precipitation changes at stations Malepatan and Khairenitar during 1999-2007

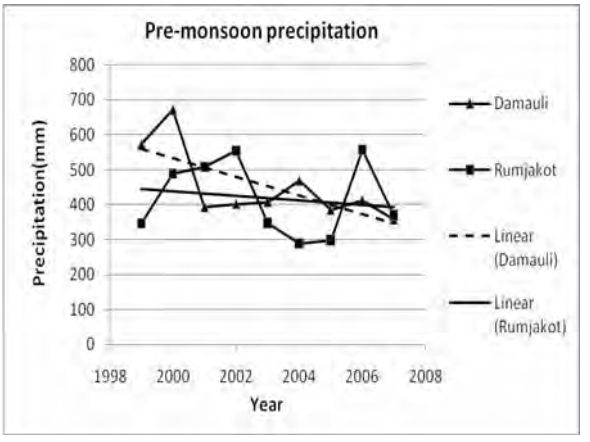

Fig. 7: Pre-monsoon precipitation changes at stations Damauli and Rumjakot during 1999 - 2007

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Brief study of depositional environment of the Terai Plain, Nawalparasi District, central Nepal

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ABSTRACT

The southern plain area of Nepal extending from east to west is called as Terai (Indo-Gangetic Plain) that consists of fluvial sediments. Terai plain is heavily populated and therefore, there is an increasing threat of environmental deterioration. The fundamental aspect required for all kinds of environmental studies in the plain is the understanding of the geology and depositional history of the sediments. Also, the notion explaining the freshwater sediments of Terai analogous to the sediment of Indo-Gangetic Plain near Bangladesh is yet to be understood. This study aims to explain depositional environment in Terai based on microfossil evidences. Observably, the sediments in Terai are rich in organic matter. Abundant microfossils found in the sediments are useful tools for the construction of geology and depositional environment of the Terai plain. This study examines microfossils recovered from borehole samples of Nawalparasi District of Nepal. The mircofossils belonging to Ostracoda (Phylum Arthropoda) and Charophytes (Algae) indicate that the Terai plain sediments were deposited in the fresh water environment during Late Pleistocene to Holocene epoch.

Keywords: Microfossil, Terai Plain, sediments, Holocene

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INTRODUCTION

Topographically, the plain to the south of the Siwalik hill sloping gently towards south is known as Terai (Fig. 1). The Terai is the part of the Indo-Gangetic Plain, which is named after the greater rivers-Ganges and Indus. The vast alluvial sediments in the Indo-Gangetic Plain is evolved as a foreland basin at the southern front of the rising Himalaya. The sediments are estimated to be more than 1,500 m thick (Sharma 1995), however, variable thickness is apparent. The number of perennial rivers and streams coming from the Himalayas make this basin wet. It contains numerous springs and marsh lands. The monsoon from the Bay of Bengal strikes the Himalaya and causes high precipitation (2,500 mm/yr). The elevation of the Terai Plain of Nepal, which generally ranges from 60 to 200 m above mean sea level, stretches from east to west along the southern border with India (Fig. 1). Soils of Terai are rich in organic matter and highly fertile in nature.

The Terai region contains 20 administrative districts. The southern part of Terai region remarkably consists of flat land. Although, the Terai constitutes less than a fifth part of Nepal's total area, it contains more than half of the total arable land.

Based on morphology and geohydrology the basin is divided into two parts: the northern Bhabar zone consisting of coarse sediments such as gravels and sands while the southern flat land consisting of fine sediments such as silts and clays. The Terai Plain is the northern marginal part of the Gangetic Plain. The Mio-Pliocene sedimentary rocks of the Siwaliks are thrust over the Terai sediments (Kansakar et al. 2004). Locally, the apices of alluvial fans extended up to the bedrock of the Siwalik hills developed with multiple generations of terraces are found at the mountain front.

The depositional environment of the Terai plain of Nepal is not yet well understood. The deposits at shallow depth contains sediments of existing rivers, but the depositional environment of the sediments in the deeper part of the plain is not well known. Study of microfossils is used here as a tool for the reconstruction of paleo-environment.

Microfossils are the hard part of very small organisms. A small amount of sediment commonly contain countless number of microfossils. Microfossils are small and abundant thus can be recovered from small samples. Most of the commonly studied groups are Foraminifera, Diatoms, and Radiolarians. Others are micro invertebrates (e.g., Ostracods)

or parts of macro invertebrates, reproductive bodies of plants (e.g., spores and pollen). Because of their diversity, abundance, and complex morphology, microfossils assemblages are useful for establishment of biostratigraphy, paleoenvironment and can give accurate relative dates to sediments and rocks.

The main objective of the study is to describe the depositional environment of the sediments in Nawalparasi area, western Nepal.

STUDY AREA

The study area is located in Nawalparasi District in the western Terai of Nepal (Fig. 1). The core samples were from collected Goini village located at about 5 km south-east from Nawalparasi (Fig. 2). The study area belongs to the middle Terai, situated at about 20 km south from the Siwalik hill.

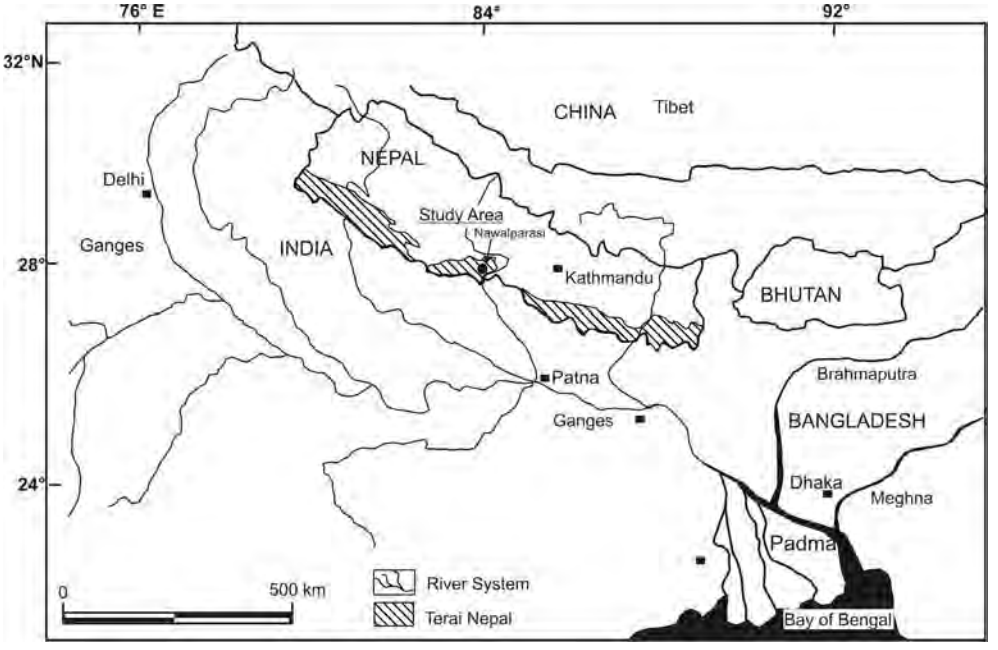

Fig.1: Location of Terai lying in the Ganges watershed

MATERIALS AND METHODS

Sample collection

Core samples of the shallow aquifers were taken by using an indigenous manual drilling percussion method, locally called *Dhikuli.* In this method a hollow steel pipe is used as a drilling rod, which is inserted downward by creating up and down motion manually (Fig. 3a) while the upper end of the pipe is kept open and closed and flapping instantly hand to create a vacuum inside the pipe. The core cutting pieces were collected by hand and packed in plastic sample bags. The method of drilling is commonly used to install hand pumps by local people. Undisturbed core samples (n = 5) of fine sediments (clay/silt) were collected for the purpose of the study (Fig. 3b).

Lithology

Lithology of shallow depth at Goini village, Nawalparasi consists predominantly of silt, clay, black clay, and fine sand (Fig. 4). The uppermost layer is yellowish brown silt. Grey clay underlies the top silt bed, and is characterized by concretions, molluscan shells, and wood fragments. A sticky black clay bed rich in calcareous concretions, organic matter and small gastropod shells occur at a depth of 12 to 15 m below ground surface (bgs). The thickness of this bed varies from 0.5 to 1 m. Very fine sand beds were found at all sites, alternating with clay beds of variable thickness (5 cm to 1 m). The fine sand is generally grey or locally multicolored (grey and yellowish brown). Clayey silts and silt layers are interbedded with clay and fine sand beds.

Some authors (Sinha and Friend 1994; Sharma 1995) believe that sediment deposition environment in the Terai plain is affected by climate change in Late Quaternary times. An attempt was made to compare and correlate the stratigraphy of Bangladesh in plain area with the sediments of Terai plain based on carbon-14 dating. Wood fragments recovered from 4 m depth bgs (columnar section, Fig. 4) give an age of 3340 ±70 yrs BP, and a molluscan shell from 11.2 m depth bgs

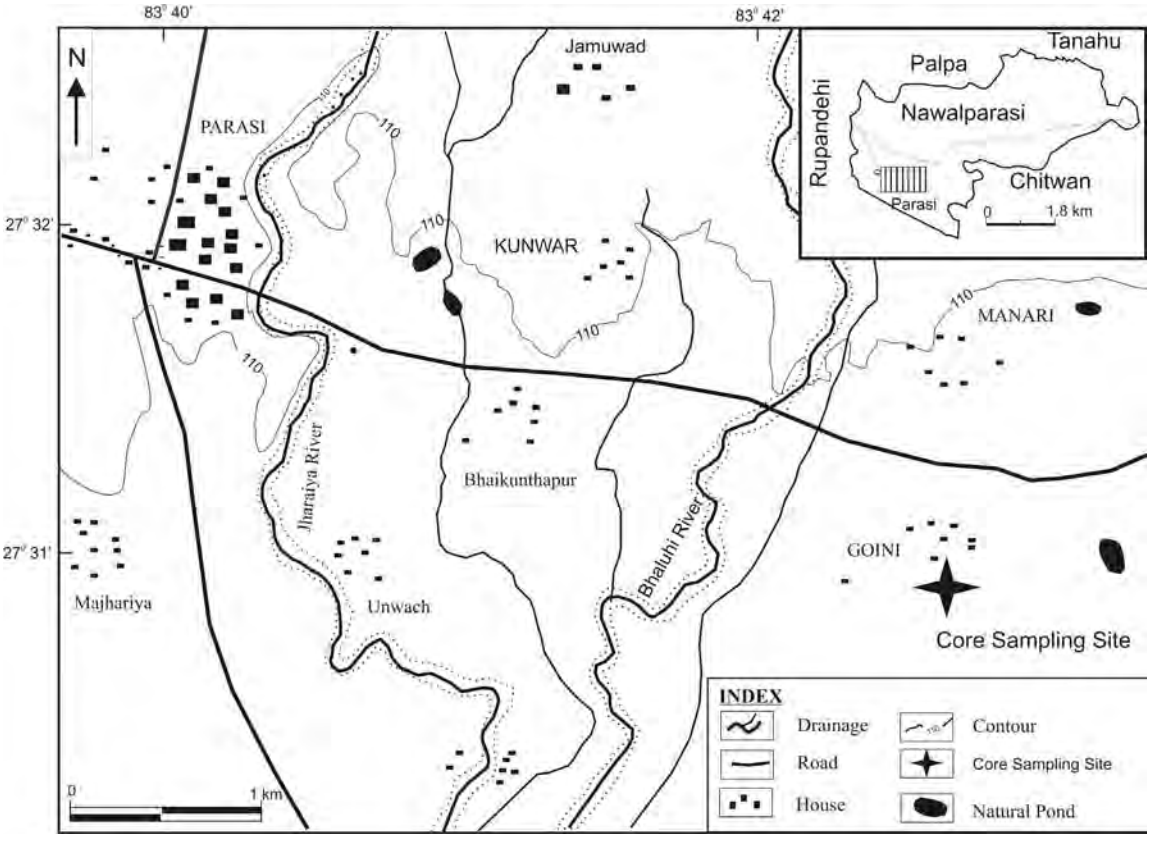

Fig. 2: Map shows the core sampling area (Goini village) situated in the headquarter of Nawalparasi District, which is shown in inset map at top right corner of the figure.

Fig. 3: (a) Method of core sample collection. (b) Core samples obtained from shallow depth at Goini village

are dated at 12680± 40 yrs BP (Gurung et al. 2005). Peat beds from shallow depths in Bangladesh also yield ^{14}C ages from 4000 to 12000 BP (Monsur 1995). The black clay bed dated at 12680 yrs BP in the present study may be correlative with the peat beds of Bangladesh that deposited during the Holocene climatic condition.

Extraction of microfossil

Microfossil preparation, extraction and study of the core samples were performed in the laboratory of Shimane University, Japan. The core samples were dried for 72 hrs at 60^0 C. Samples were then weighted and treated with petroleum

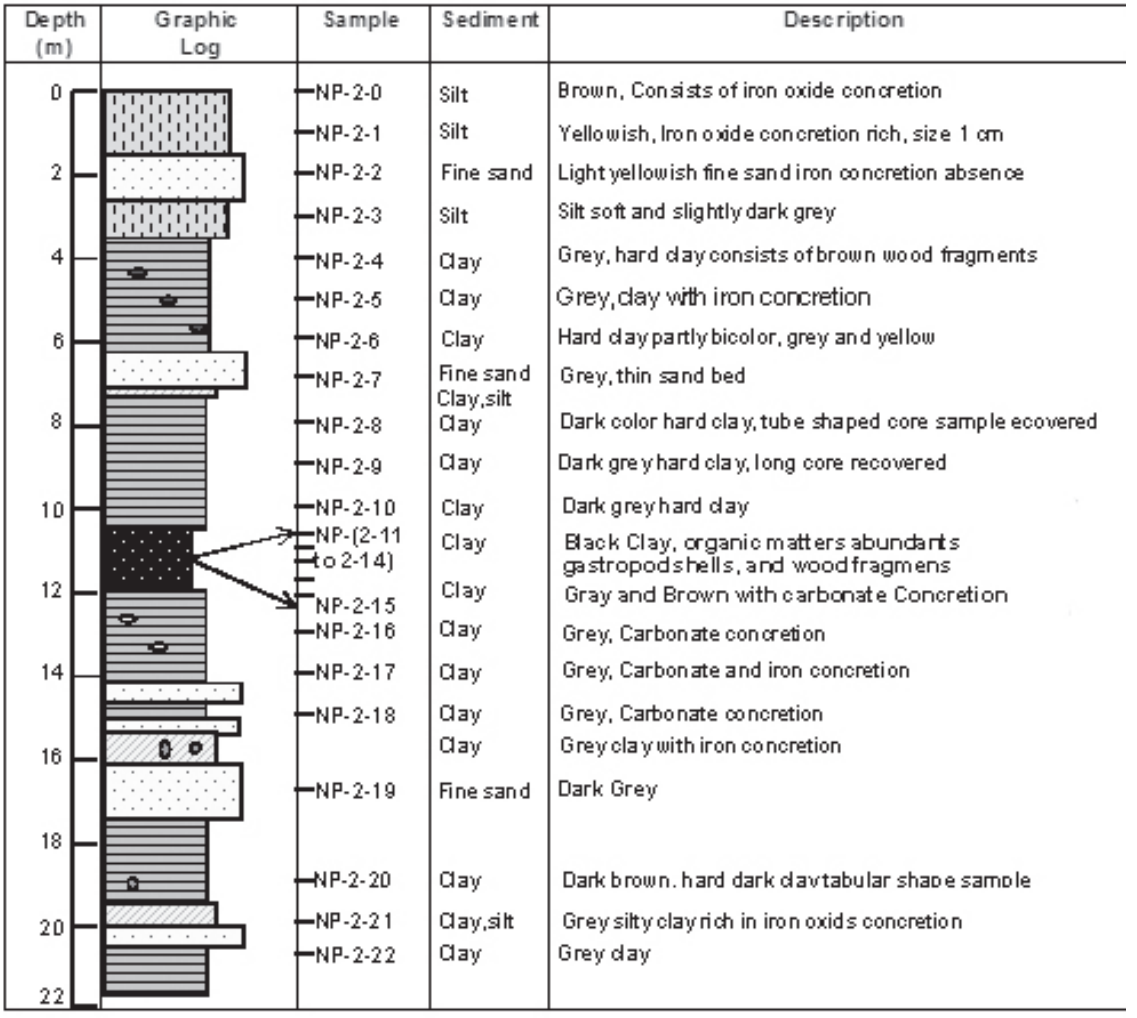

Fig. 4 : Litholog of borehole opened at Goini village, Nawalparasi District, Nepal

oil (naphtha) for half an hour before heating with water in an evaporating draft system for 2 hours.Samples were then washed through a 75 ì m mesh. Dry sieving was done to retrieve the >125 ì m fraction. Then microfossils were picked up by using binocular stereo microscope. Photographs of fossils were taken using binocular stereo microscope in transmitted light.

RESULT AND DISCUSSION

The microfossils recovered from the core samples belong to Ostracoda and Charophyes.The Ostracoda are diverse group of small Crustaceans (Phylum: Arthropoda, Class: Crustecea). They can live in wide range of aquatic environments from the deep sea to mountain springs. Ostracods possess a dorsally hinged, bivalved carapace, which is laterally symmetrical. The most important characteristic of Ostracoda is their sensitivity to environmental change. Even slight changes in environment can bring a change in species composition and structure of living populations. Therefore, abundance of each species in assemblages yields important information on environmental conditions.

Darwinula sp.(Fig. 5A) belong to the superfamily of the order Myodocopida and is a typical freshwater species. They usually have thin shelled, smooth carapace, markedly elongated in lateral view (Boomer 2001). Similarly, *Fabaeformiscandona* sp. and *Strandesia* sp. are two other freshwater species recovered from same samples of Goini village (Figs. 5B and 5C). These types of species have been already discovered in China (Yin and Martens 1997). Genus and the specific name of fourth Osctracoda (Fig. 5D) could not be identified.

algae normally found in freshwater environment. *Chara* grow submerged attached to the muddy bottoms of pools

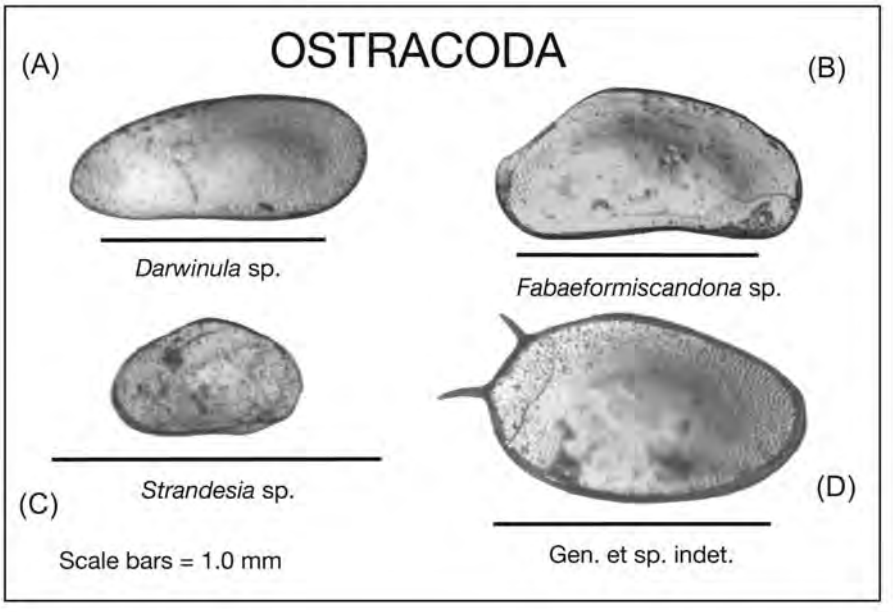

Fig. 5: Ostracoda species, recovered from core sample, Goini village, Nepal

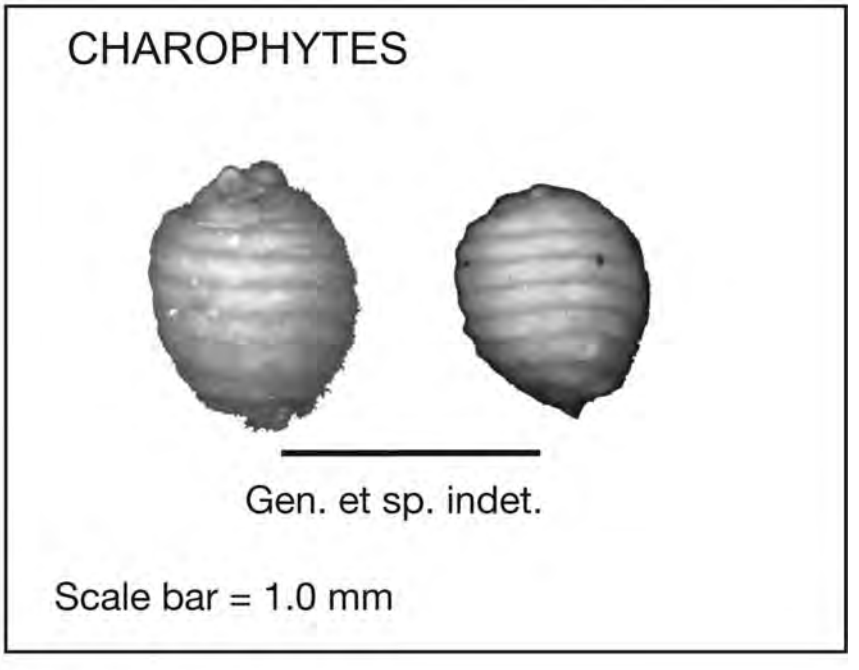

Fig. 6: Charophyes (Green algae) recovered from core samples from Goini Village, Nepal

and ponds of clear water. They are commonly found in less oxygenated hard water. Nucules are male reproductive or fructification organ of *Chara*. Charales are also known as 'stoneworts' because layers of CaCO3 is deposited on their body surface due to which they can be easily fossilized after their death (Fig. 6). The exact taxonomical identification could not be established from the Charophytes however they confirm the freshwater environment. The Bay of Bengal is approximately 800 km south east from the Terai plain (Fig. 1). Geomorphologically, the study area is the alluvial fan of the Ganges river system. The sediments in the Terai of Nawalparasi were deposited in the reducing fresh water environment as manifested by the Ostracodes and black carbonaceous matters at the time of around Holocene and Pleistocene boundary.

CONCLUSION

Based on the carbon dating of wood fragments preserved in clay beds in the Terai at 4 m bgs and the peat beds found in the Bangladesh were chronologically deposited at the similar geological age. However, Ostracod species recovered from the core sample at Goini village (Fig 5) are typical fresh water species. *Darwinula* sp. (Fig 5A) is exclusively freshwater, usually with thin, smooth carapace, markedly elongated in lateral view (Boomer 2001). Similarly, *Fabaeformiscandona* sp. and *Strandesia* sp. (Figs 5B and 5C) are the other two freshwater species (Yin and Martens 1997). Therefore, the sediments in Terai were deposited in fresh water environment in the Holocene epoch.

ACKNOWLEDGEMENT

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Hydrogeological study of shallow and deep aquifers in Balaju-Boratar area, Kathmandu, central Nepal

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ABSTRACT

Groundwater is the main source of water for the industries of Balaju Industrial District (BID) and the denizens of Balaju-Boratar area. Quantity of groundwater is in fatal condition in the area than earlier days. Water levels in shallow wells lowered significantly and deep wells are not providing adequate amount of water as before because of higher extraction rate than recharge rate. The main recharge zone of the shallow aquifer lies at the foot of Nagarjun mountain, where recent colluvial debris are accumulated. Urbanization in the area is the main reason for decreasing water table. Recharge source for deep aquifer in the region is aquiclude leakage. Sand layer above the Kalimati clay is the shallow aquifer zone, which is limited only in Balaju and eastern part of the Boratar, while the layer below the Kalimati clay spreading around Gongabu, Machhapokhari and Balaju area is considered as a potential area of deep aquifer. Over extraction of groundwater without considering water balance in the aquifers may dry out the source and can initiate land subsidence problem. Hence, all the responsibilities of the industries in BID area and the denizens of Balaju-Boratar area should be encouraged to practice artificial groundwater recharge.

Keywords: Aquifer, aquiclude, Kalimati clay, flow net, fence diagram

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INTRODUCTION

The study area including Balaju Industrial District (BID) covers the junction between Nagarjun hill and the north-west plain of the Kathmandu Valley (Figs. 1 and 2). The area is comprised by flat to gently sloping terrain. Large part of the study area is drained by the catchment of Ghon Khola, which joins to the Bishnumati River. Bishnumati River flowing through the eastern boundary of the area is situated at an altitude of about 1300 m above mean sea level (amsl). The catchment area of the Ghon Khola characterized by dendritic drainage pattern is approximately 8.20 sq. km (Fig. 3).

The study aims to locate the recharge zones for shallow and deep aquifers and to determine flow direction of groundwater in the area.

METHODOLOGY

Data on water level of each well (n=11) were acquired from measurement of the level from ground surface during field survey (Figs. 2 and 3). Based on field and other data, groundwater contour map and flow net were prepared. Geomorphology and land use pattern of the study area were examined on the aerial photographs (no.17-003/004; 17-005/006) of 1998 obtained from the Department of Survey, Government of Nepal.

LAND USE PATTERN

Three major land use types are identified in the area with varying proportion of coverage (Air photo No.17-003/004; 17-005/006). The settlement / built-up area covers approximately over 70% land; forest covers about 10%, while the agricultural area covers about 20% of the total land. The ridge of Nagarjun hill extending towards Balaju separates the watershed of northeast area (Mahadev Khola, Bishnumati River) from southwest (Ghon Khola, Bhaucha Khusi).

GEOLOGICAL SETTING

Kathmandu Valley is an oval-shaped intermountain basin stretching 30 km from east to west and 25 km from north to south. It covers an area of about 650 km^2. Geologically, the Kathmandu Basin lies on the rocks of the Kathmandu Complex (Stocklin and Bhattarai 1977; Shrestha et al. 1998). It is a piggy-back basin lying between the Mahabharat Lekh to the south and Shivapuri Lekh to the north (Sakai 2001; Fig. 4). The basin is filled by more than 500 m thick Quaternary sediments in the central part.

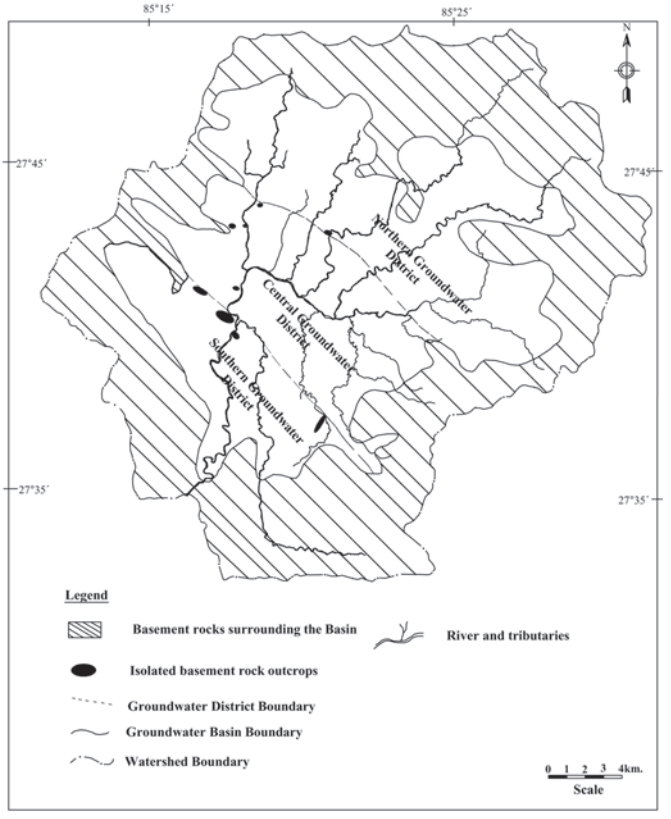

Fig. 1: Location of study area (modified after JICA 1990)

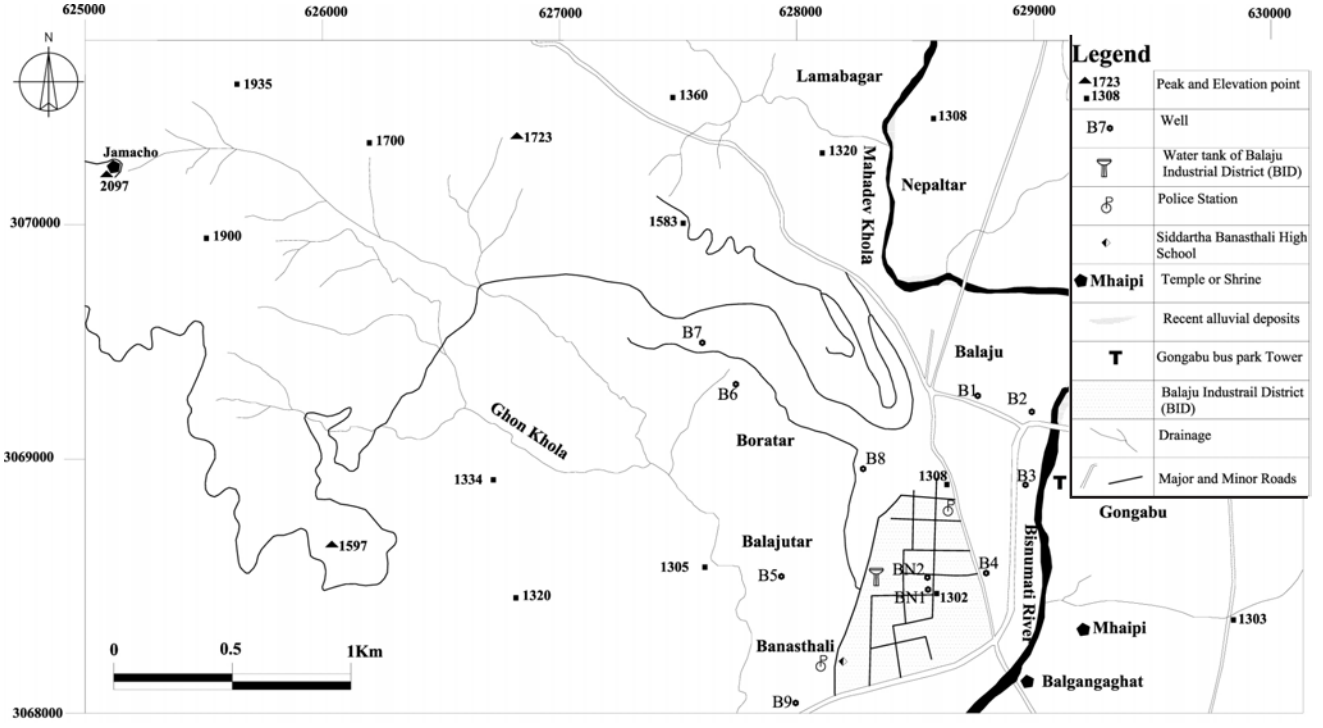

Fig. 2: Location of studied wells

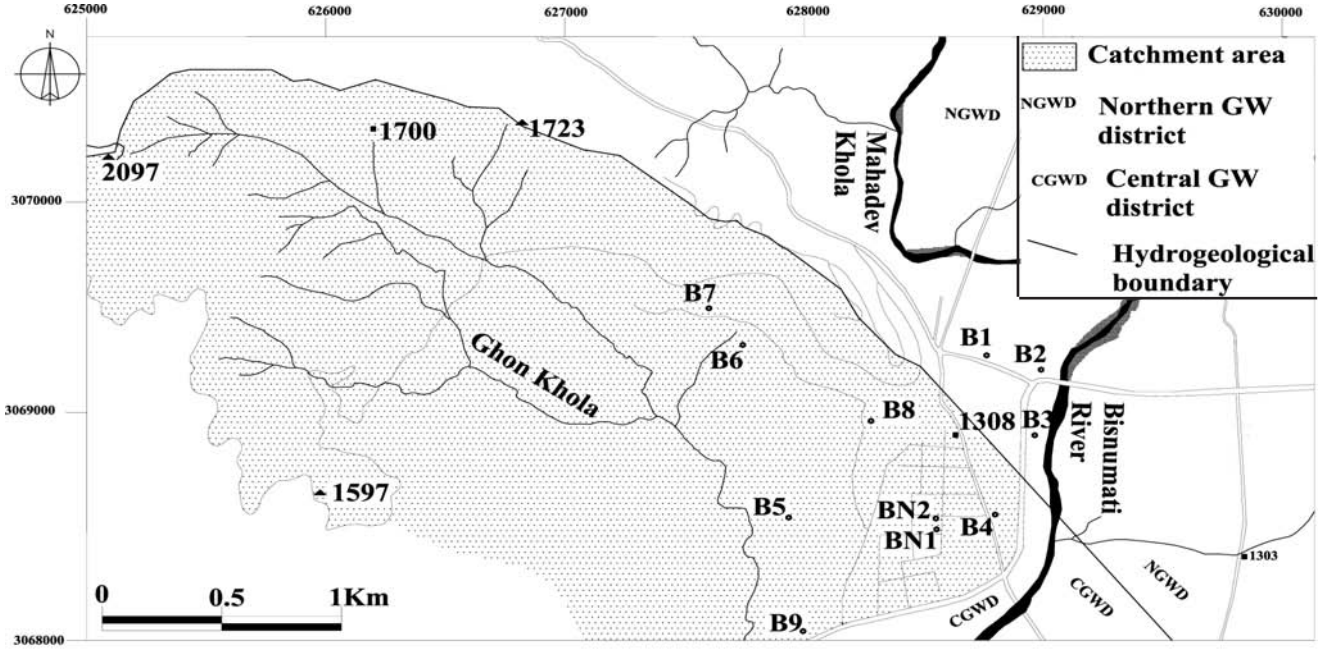

Fig. 3: Catchment area of Ghon Khola

Basement Geology

In the study area, basement rocks are comprised of Chandragiri Limestone of the Phulchowki Group (Stocklin and Bhattarai 1977, Shrestha et al. 1998; Fig. 5). The main rock type of the Chandragiri Limestone is well bedded to massive, finely crystalline, siliceous to partly dolomitic, pale bluish grey/brown limestone containing abundant crinoids and echinoderms.

Sub-surface Geology

The basin fill sediments near the mountain slopes are partly covered by thin to thick piles of very poorly sorted colluvial debris consisting of limestone pebbles/cobbles, sandy gravel and clay (Fig. 5). The basin fill sediments have been studied by many researchers (Yoshida and Igarashi 1984; Shrestha et al. 1998; Sakai 2001).

Basal Boulder Bed

It is the oldest basin-fill sediments unconformably overlies the basement rocks of the Kathmandu Complex. This unit is exposed at the south western part of the Kathmandu Valley lying outside from the study area. It consists mainly of boulder to cobble conglomerate, silt and sand layers. The clasts consist of quartzite, granite, gneiss and metasandstone with silty matrix derived from the Phulchauki-Chandragiri Range. Thickness of the formation is more than 100 m (Shrestha et al. 1998) and the deposits have high transmissivity and permeability.

Kalimati Formation

Kalimati Formation is exposed in Boratar and Balajutar area (Fig. 5). It consists of laminated, dark grey carbonaceous clay (locally known as 'Kalimati clay'), silty clay and clayey silt. Medium to coarse-grained sand appeared in the middle part of the formation is extensively distributed beneath the Gokarna Formation (Sakai 2001). The lower part of the formation consists of lignite and bituminous pebbly mud beds rich in carbon designated as the "Basal Lignite Member" (Sakai 2001). Thickness of the formation is up to 450 m or more (Shrestha et al. 1998). The sediments of the formation were deposited in lacustrine environment and act as an aquiclude or aquitard material having extremely low permeability.

Gokarna Formation

The Gokarna Formation is exposed in Gongabu, Mhaipi and eastern part of BID area (Fig. 5). It is comprised of thinly laminated, poorly sorted, light to brownish grey silty sand and clay. The sediments of the formation were accumulated in fluvio-deltaic environment. Total thickness of the formation is up to 300 m or more (Shrestha et al. 1998). This formation contains good aquifer material and is appropriate for groundwater extraction from shallow depth.

Tokha Formation

Tokha Formation is exposed to the north of Balaju around Manamaiju, Nepaltar and Lamabagar (Fig. 5). It consists mainly of dark grey clay, brownish grey sand and poorly sorted, sub-angular to rounded sandy gravel with occasional peaty clay and lignite layers. Thickness of this formation is up to 200 m or more (Shrestha et al. 1998). This formation contains good aquifer material and is appropriate for groundwater extraction from shallow depth.

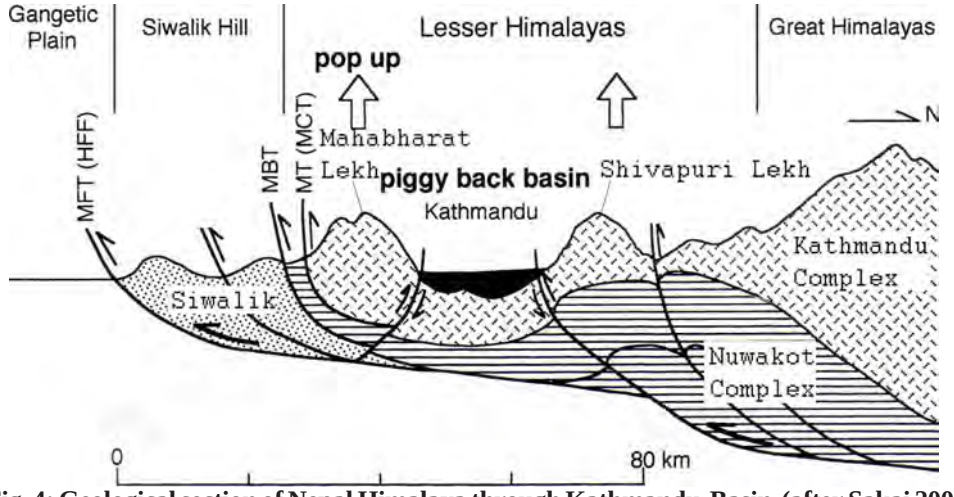

Fig. 4: Geological section of Nepal Himalaya through Kathmandu Basin (after Sakai 2001)

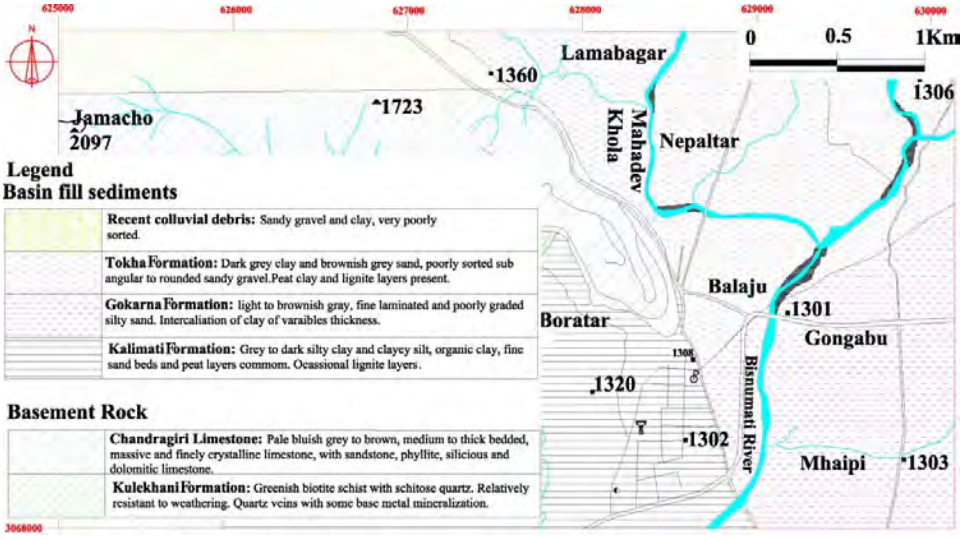

Fig. 5: Geology of the study area (modified after Shrestha et al. 1998)

AQUIFER SETTING

Aquifers are the geological formations which are permeable enough to transmit water through them to yield sufficient quantity of water to the wells and springs. Sand, gravel, limestone, sandstone, fractured igneous and metamorphic rocks are typical aquifer materials. Those subsurface sediments or rocks that do not transmit water readily through them are referred to as aquicludes or aquitards e. g., clay, shale, silt, unfractured igneous and metamorphic rocks.

The groundwater system of the Kathmandu Valley is considered as a closed and isolated groundwater basin, with more or less interconnected aquifers. Most of the sediments in shallow depth of northern and northeastern area, and deeper parts (>90 m.) of the central and southern provinces form good aquifer zones (BGR 1998). Geologically, the deep aquifer horizon distributed more or less continuously in lateral direction is the basal gravel bed, which overlies the basement rocks in the southern part of the valley.

JICA (1990) divided the Kathmandu Basin into three groundwater districts as Northern Groundwater District (NGWD), Central Groundwater District (CGWD) and Southern Groundwater District (SGWD) based on the physical and chemical properties of groundwater and geological structures (Fig. 1). Sediments in the NGWD are composed of unconsolidated highly permeable micaceous sandy and gravelly materials (wells B1, B2 and B3; Figs. 2 and 3). The CGWD is characterized by the presence of predominant impermeable, very thick, black stiff clay

(Kalimati) accompanied by some lignite layers of pure lacustrine origin. The area of BID lies within the CGWD (wells BN2, B4, B5, B5, B7 and B8; Figs. 2 and 3). The SGWD is characterized by the intermediate-size gravel of low transmissivity overlain by a thick impermeable clay formation having relative thickness of about 180 to 100 m.

The study area lies in the CGWD consisting of impermeable black Kalimati clay accompanied by some lignite and peat with a maximum depth of 200 m (Fig. 5). Unconsolidated coarse sediments of low permeability underlie the thick impermeable black clay. Recent colluvial debris at foot of the Nagarjun hills consisting of highly permeable gravel, fine, medium to coarse-grained sand cover the black Kalimati clay (Fig. 5). It forms a potential shallow aquifer zone. The study area is characterized by two aquifer zones; aquifer materials comprising sand and gravel with high permeability at the top of Kalimati clay and aquifer materials comprising coarse sediments of low permeability underneath the clay horizon (Fig. 6). The transmissivity of the aquifer ranges from 32 to 960 m^2/day (JICA 1990). Fence diagram (Fig. 6) of the study area and its periphery is prepared by using accessible and suitable lithologs of the site viz. MK1, P1, P4, B15, BN3 and GB2. All the wells touch the bed rocks except BN3. The wells MK1, P1, P4, BN3 and GB2 have contacts with the basement rocks of Chandragiri Limestone while B15 has touched the basement rocks of Kulekhani Formation. The basement rocks are lying at shallow level at P1 well (<80 m below ground level (bgl)) to deep level at MK1 (about 200 m bgl) and P4 wells (about 140 m bgl) (Fig. 6). The subsurface rock outcrop separates MK1 lying in NGWD from P4 of CGWD. The subsurface rock exposure is continuous in the area of B15 well at the depth of <140 m. Sand layer lies above and below the Kalimati clay and the lower layer seems to be widely distributed in the basin (Fig. 6). The upper sand horizon is a shallow aquifer of the area found at BN3, P1, MK1 and GB2 wells. At Swayambhu nearly 210 m thick clay layer is appeared above the basement rocks comprised by sandstone.

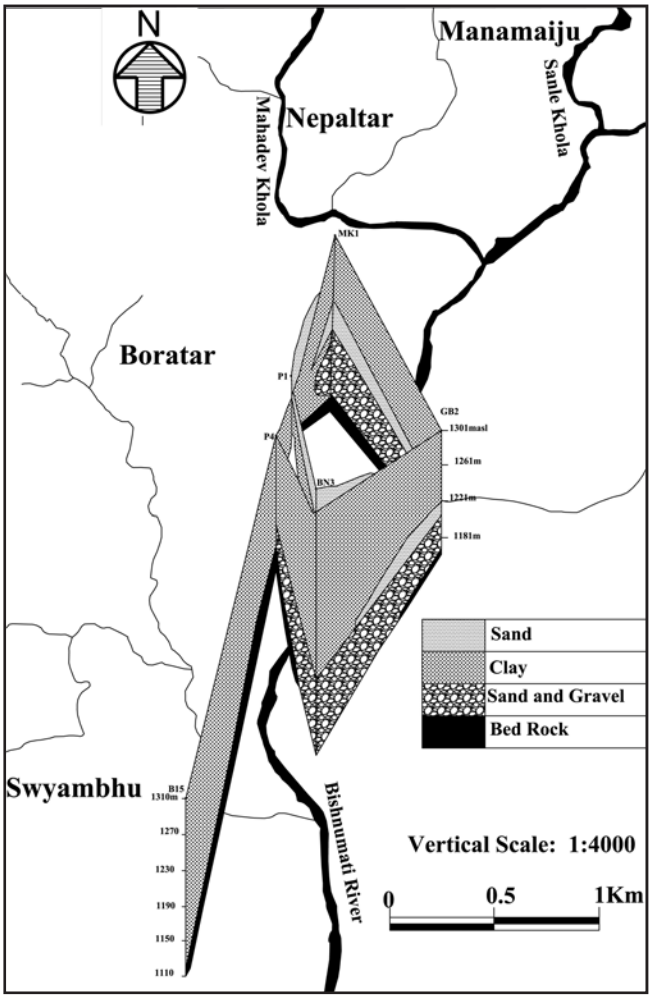

Fig. 6: Fence diagram of the study area

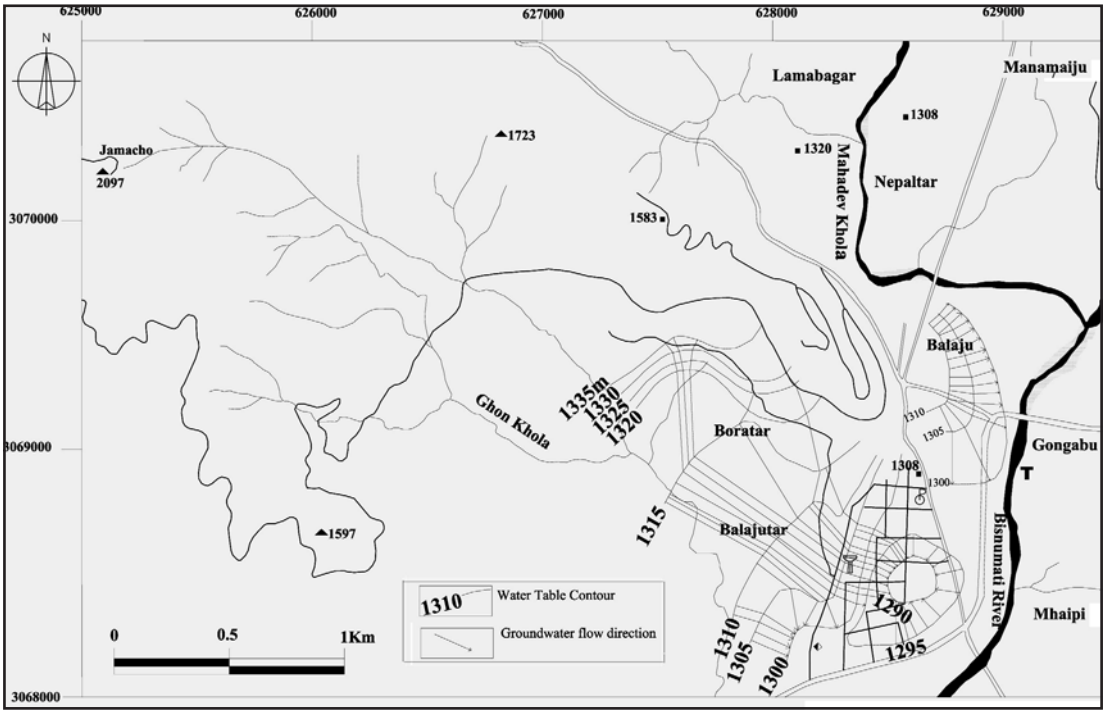

Fig. 7: Groundwater contour below ground level in the study area

HYDROGEOLOGY

Groundwater contour below ground level

Groundwater level measured at the Balaju area is presented in Table 1. The water table contours slope to northwest at Boratar and Balajutar area, follow the sloping pattern of land surface (Fig. 7). Contour lines are close at Boratar and Balajutar area. In contrast, at BID area, the groundwater contours are very steep while the land surface is relatively flat. It can be concluded that extraction of groundwater in the region is high and recharge is very minimal.

At Balaju-Gongabu site lying in the NGWD, ground elevation decreases rapidly to east from west, where groundwater level does not decrease rapidly (Fig. 7) illustrating that recharge is nearly equal or more than discharge.

Hydrogeological cross-section

Lithologs of six deep tube wells from Mahadev Khola area (MK1) through BID to Swayambhu area (B15) are taken into consideration for the preparation of hydrogeological cross-section (Fig. 8). Medium to coarse sandy layers situated above thick clay layer lying between 1300 m at BNL wells and 1345 m at MK1 form potential zone for shallow aquifer (designated by "Z" in Fig. 8). However, this layer seems to pinch towards south of BID area. Thickness of the shallow aquifers in the area ranges from approximately 3 to 12 m (BN3).

The coarse sand and gravel beds immediately underlying the thick clay layer cover the basement rocks. The beds are encountered at the elevation of 1260 m amsl at MK1; 1280 m amsl at P1; 1250 m amsl at P4 and 1235 m amsl at B15, and are designated by "X" in Fig. 8, which form the deep aquifer zone .

Flow net

Flow net is prepared on the groundwater contour map (Fig. 9). Nearly all flow lines concentrating towards centre of BID form centripetal pattern, which indicate that the BID zone lies in the highest water extraction area. Few flow lines tend to divert towards east of Siddartha Banasthali High School, which indicates another high groundwater extraction site. Flow lines do not show any recharge zone. Hence, recharge is minimal in comparison to extraction. Around Balaju-Gongabu area, flow lines are nearly parallel and it indicates that recharge is equal to discharge in the region. Aquifer seems to be being recharged from near Gongabu site, natural ponds of Machhapokhari and seepage from the Chandragiri Limestone.

Groundwater recharge

The recharge condition within the Kathmandu Valley is greatly influenced by the type of valley-fill sediments. The deposits within the valley are predominantly of lacustrine

Table 1: Water level data of Balaju area observed in 7th September 2009

S.N.	Well No.	Co-ordinates		Elevation (m, amsl)	Water Level Depth (m, bgl)	Water Level (m, amsl)
		Latitude	Longitude			
1	B1	27°43'47.2"	85°17'47.1"	1310	0.78	1309.22
2	B2	-	-	1300	3.1	1297.9
3	B3	27°43'53.9"	85°18'27.4"	1301	2.31	1298.69
4	B4	27°43'46.9"	85°18'14.9"	1302	5.66	1296.34
5	BN1	27°43'45.5"	85°18'09.9"	1302	24.65	1277.35
6	BN2	27°43'46.4"	85°18'12.4"	1302	9.32	1292.68
7	B5	27°43'49.0"	85°17'48.6"	1320	11.74	1308.26
8	B6	27°44'08.9"	85°17'42.0"	1330	8.75	1321.25
9	B7	27°44'11.3"	85°17'37.8"	1340	3.75	1336.25
10	B8	27°44'01.1"	85°17'56.1"	1318	5.43	1312.57
11	B9	27°43'27.0"	85°17'41.3"	1310	8.04	1301.96

origin. Furthermore, the flat ground surface of low land area is covered with silty clay. Therefore, infiltration of rainwater into the shallow aquifer is quite limited, although annual precipitation within the Kathmandu Valley is high. The total infiltration area for the unconfined shallow aquifer in the Kathmandu Valley is about 86 km^2, which is about 26% of the total area of the whole groundwater basin (JICA 1990). The recharge sources for the main confined aquifer in the Kathmandu Valley are squeezed from the confining strata or the leakage water of the unconfined aquifer through the aquiclude (impermeable Kalimati clay).

DISCUSSION

In the past, Balaju had plenty of water for domestic, agriculture as well as industrial purposes. Maximum groundwater extraction in BID, Balajutar and Boratar area has nearly dried up shallow aquifer, which was once the potential source of groundwater (Fig. 1). Balajutar and Boratar areas are the main recharge zones for the shallow aquifers of this region (Fig. 2). Water from deep aquifer is being extracted for industrial as well as for household purpose to solve water crisis. However, the deep aquifer seems to be temporary solution only. Over extraction of water from deep aquifer may be hazardous in future as it may provoke land subsidence problem.

One of the major causes of limitation in recharge zone is the rapid growth of population, urbanization and industrialization, which have drastically changed the land use pattern of the area over the last decade. For example, the forest land seems to be limited towards north in the Balaju-Raniban area, while the large portion of agricultural lands have been replaced by built-up areas. Recharge capacity of shallow aquifers has been lowered by reducing percolation rate of rainwater into the ground.

Fence diagram and hydrogeological zigzag cross section do not show any recharge zone for deep sandy aquifer nor for deep basal gravel aquifer. Thus, the aquifer recharge should depend upon the seepage of water from

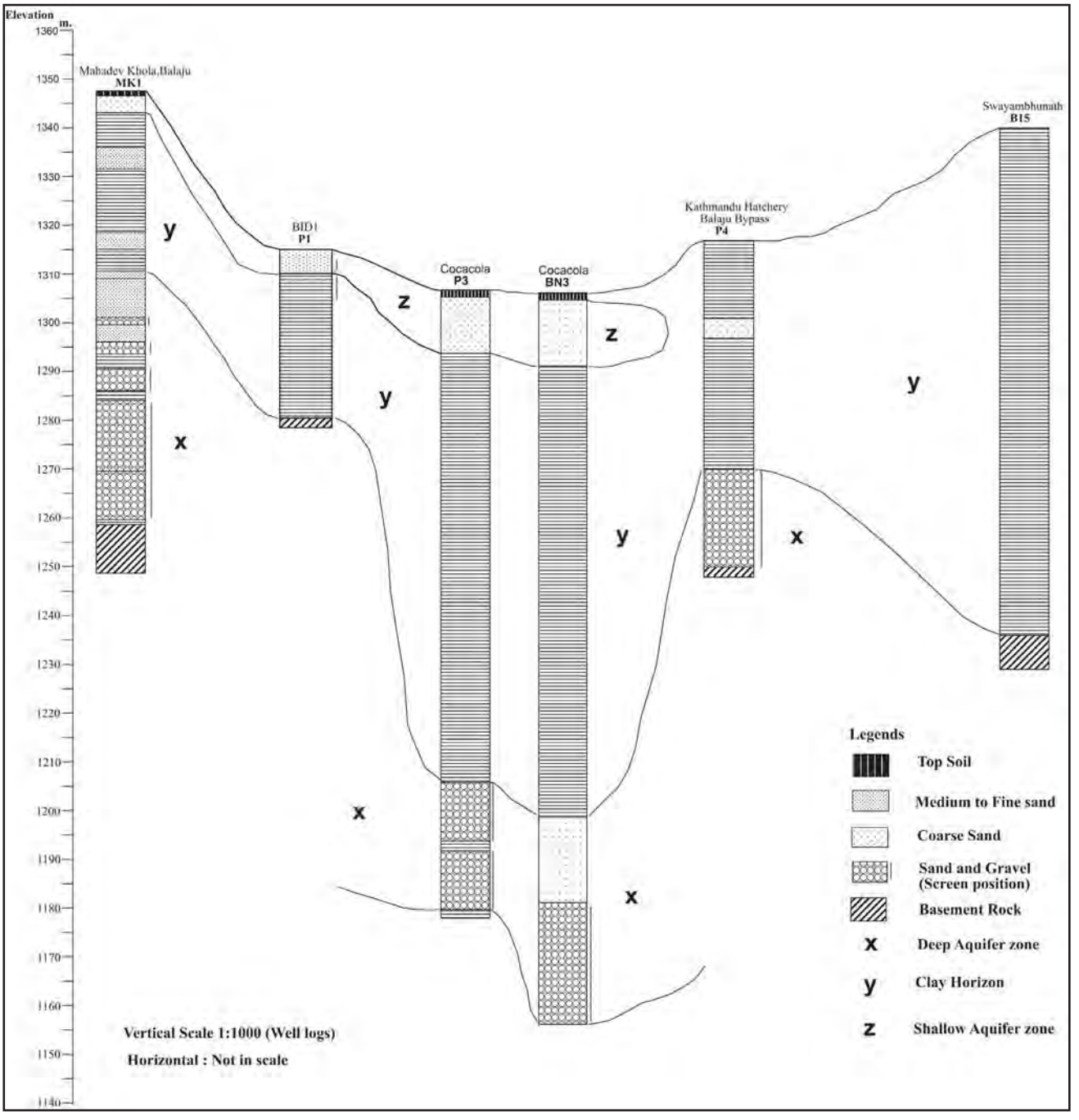

Fig. 8: Hydrological zigzag cross section from MK1 to B15

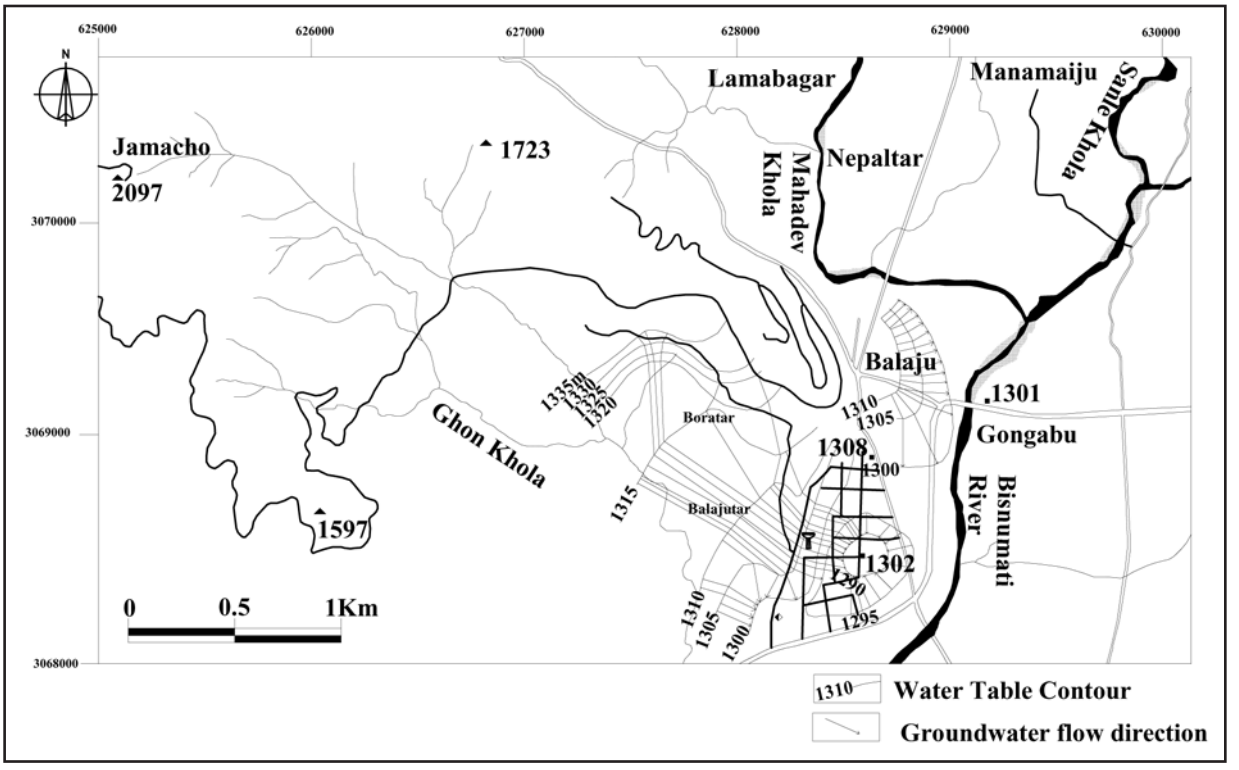

Fig. 9: Grounwater flow net of the study area

thick clay layer. Ignorance on artificial recharge practice may bring fatal condition in near future decades (Figs. 6 and 9).

CONCLUSION

Balajutar and Boratar area are the main recharge zones for the shallow aquifer. Groundwater flows to SE in Boratar-Balajutar area, while the flow direction in Balaju-Gongabu area is toward EW. Recharge is minimal in comparison to discharge in Boratar-Balajutar area, in contrast recharge and discharge seem to be balanced condition in Balaju-Gongabu area. Groundwater zone is divided by submerged ridge, which runs from P1 towards GB2. Deep sand layer may not be available at the BID zone, which lies in the Central Groundwater District.

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काठमाडौँ सहरका नदीनालाको वातावरणीय पुनर्स्थापनका चुनौतीहरू

नरेशकाजी ताम्राकार
भूगर्भशास्त्र केन्द्रीय विभाग, त्रिभुवन विश्वविद्यालय, कीर्तिपुर, काठमाडौँ

सारांश

नदीनाला प्राकृतिक सम्पदा भएकाले यिनको उचित तथा व्यवस्थित सदुपयोग र संरक्षण गर्नसके यिनबाट धेरै फाइदा लिन सकिन्छ । तर दुर्भाग्यवश काठ्माडौँका नदीनालाले मानव सिर्जित विषम परिस्थितिको सामना गरिरहेका छन् र विगत् केही वर्षदेखि वातावरणीय समस्याबाट तीव्ररूपमा प्रभावित भएका छन् । काठमाडौँका नदीनालाहरू दिनानुदिन भूक्षय, अतिक्रमण एवं मानवसिर्जित फोहर मिसाइएका कारणले झण्डै फोहर बग्ने ढलको रूपमा परिवर्तन हुँदैछन् । नदीको स्थानीय धारमा पर्ने असरले दीर्घकालीन रूपमा नदीको जलाशय आयतनमा समेत असन्तुलन पुर्‍याउने हुनाले नदीको पुनर्स्थापन गर्न यथोचित अध्ययन, अनुसन्धान एवं अल्पकालिन् तथा दीर्घकालीन योजना तर्जुमा र प्रशस्त लगानीको आवश्यकता पर्दछ । काठ्माडौँका नदीहरू वर्तमान अवस्थासम्म आइपुग्नका लागि चेतनाको अभाव, फोहोरमा सत्ताको राजनीति तथा बढ्दो सहरीकरण जस्ता विभिन्न कारणहरू जिम्मेवार देखिएका छन् । नदीहरूको पुनर्स्थापन कार्यमा यिनै कारणहरूले चुनौति पनि उब्जाएका छन् । काठ्माडौँका नदीनालाको पुनर्स्थापनका लागि तत्काल केही कदमहरू चाल्नु आवश्यक देखिएको छ ।

नदी पुनर्स्थापन के हो ?

नदी पुनर्स्थापनको अर्थ दुई किसिमबाट लाग्न सक्छ । जस्तै पहिलो पुनर्स्थापन (rehabilitation) र दोश्रो पुनर्निर्माण (restoration) । पुनर्स्थापनले प्रदूषित भैसकेको नदीलाई अहिलेकै बदलिँदो परिस्थितिमा सकभर संरचना, इकोसिस्टम् तथा प्रक्रियालाई प्रतिस्थापन गर्ने वा पुनउपयोगी बनाउने जनाउँछ भने पुनर्निर्माणले नष्ट भैसकेको नदीलाई नष्ट हुन अगाडिको संरचना तथा इकोसिस्टम्मा स्थापन गर्नु जनाउँछ । पुनर्स्थापन कार्यद्वारा दुवै शब्दलाई समेटिन खोजिएको छ । नदीको वातावरणीय प्रतिकूलता तथा जलाशय क्षेत्रको भूपरिचालनका परिवर्तनका आधारमा कतै पुनर्स्थापन त कतै पुनर्निर्माण गर्न सकिन्छ । सहरीक्षेत्रमा जहाँ बाक्लो बस्ती छ र जहाँ नदी अत्यन्तै नष्ट भैसकेको छ त्यहाँ प्रायः पुनर्निर्माण सम्भव छैन । त्यस स्थितिमा नदीलाई पुरानै अवस्थामा फर्काउने कार्य वैज्ञानिक हुँदैन । किनभने नदी आफैँमा शक्तिवान हुन्छ र समय अनुसार परिवर्तित वा प्रतिस्थापित हुने आकाङ्क्षा राख्दछ।मानव प्रभावविहीन अवस्थामा नदी प्रतिस्थापन मुख्य रूपमा सेडिमेन्ट बहाव, यसको नाप, नदीको भिरालो तथा वहाव (discharge) अनि आधारभूत कुरामा निर्भर गर्दछ । साधारणतयाः थेग्रान (sediment) बहाव र यसको नापलाई नदीको भिरालो तथा प्रवाहले सन्तुलित राख्दछ । यीमध्ये कुनै पनि अवयवमा थपघट भएमा नदीले आफ्नो मार्ग प्रतिस्थापन गर्न खोज्दछ र आफ्नो शक्तिमा सन्तुलन (dynamic equilibrium) राख्न खोज्दछ । पुनर्स्थापन कार्यका लागि नदीलाई तीन चरणमा व्यापक अध्ययन गर्नु पर्ने हुन्छ । चौथो चरणमा यसलाई निरीक्षण तथा प्रमाणीकरण गरिन्छ । त्यसपछि पुनर्स्थापन कार्यको रचना (design) गरिन्छ र पुर्नस्थापन कार्य गरिन्छ । यी कार्यहरूमा मुख्यतः जलाशयमा तथा नदीको बगरमा भूक्षय नियन्त्रण गर्ने, जस्तै सम्बन्धन कार्य (पीँध स्थिर कार्य, पीँध कन्धनी कार्य, बाँध निर्माण कार्य), दीर्घनिर्माण कार्य (पर्खाल निर्माणकार्य, पानी बहावको रीति नियन्त्रण कार्य, पीँध छपाइ कार्य), जलमार्ग कार्य (शक्ति नियन्त्रण कार्य), पहाडी भेग आधार कार्य (अवरोध बाँध, भीर व्यवस्थापन कार्य, जलकार्य, वनस्पतिक कार्य) आदि पर्दछन् भने यसको साथसाथै नदीका संरचना परिवर्तन कार्यहरू जस्तै नदीका हिस्साहरूमा चौडाइ र गहिराइ बीचको अनुपात व्यवस्थापन गर्ने कार्य, पीँधको बनोट थपघट गर्ने कार्य, आदि पनि पर्दछन् । यीबाहेक नदीको वातावरण सन्तुलित राख्न बगरको दायाँबायाँ वनस्पतिक पेटी निर्माण गर्ने, जलाशय प्रभावित क्षेत्र (floodplain) व्यवस्थापन गर्ने, सडक पिच गर्ने, ढल व्यवस्थापन गर्ने, नदीबाट फोहोर तह लगाउने, नदीको बहावमा निरन्तरता दिन सतही जल व्यवस्थापन (surface water management) गर्ने, आदि महत्वपूर्ण कार्य पर्दछन् ।

सहरी नदीको अवस्था

सहरी नदीनाला द्रुत गतिमा बढ्दै मानवबस्ती तथा संरचनाका बीच भएर बग्ने हुँदा यस्ता नदी प्रायःजसो मानव सिर्जित वाधा व्यवधानका कारण प्रत्यक्ष रूपमा असर परिरहेका हुन्छन् । फलस्वरूप सहरी नदीको प्राकृतिक स्वरूप तथा बहाव विभिन्न कारणले प्रभावित भएका हुन्छन् । काठमाडौँका नदीहरूको (चित्र नं. १) उपल्लो धार अथवा जलाशय वर पर पिउने पानी तान्ने काम बढ्दो छ । यसबाहेक सिँचाइका लागि नदीबाट पानी लगिएको छ । नदीको धारछेउका इनारबाट पानीको प्रयोग भएको छ । यहाँका नदीहरूको विभिन्न हिस्सामा छेउ कटान् भएको पाइन्छ (चित्र नं. २) । काठमाडौँका नदीहरूमध्ये सबैभन्दा बढी छेउ कटान् गरी सर्ने नदी मनहरा हो । करीब १० बर्षमा झण्डैझण्डै १४० मिटर यसको केन्द्रीय धार सरेको पाइएको छ (Bajracharya 2006) । त्यस्तै यसको धारको चौडाइ ३२ प्रतिशतले फुकेको छ । यसले के देखाउँछ भने मनहरा नदीको किनार अस्थिर अवस्था (laterally instable

condition) मा छ । मनहरा नदीको उपल्लो धारमा पीँध कटान् (degradation) को समस्या छ भने मध्य र तल्लो धारमा सेडिमेन्ट थुपार्ने (aggradation) कार्य प्रभावकारी छ । मनहरा नदीको चौबीस ठाउँमा गरिएको सर्वेक्षण अनुसार बगरको स्खलन दर प्रति बर्ष ०.३३ मि. मान्दा तुलनात्मक सेडिमेन्ट घाटा (Relative Sediment Loss) प्रति बर्ष १२४३ टन हुन आउँछ (Shrestha 2007; Shrestha and Tamrakar 2008) । तर आठवटा बगरको निरीक्षणबाट प्राप्त खास स्खलन दर प्रति बर्ष १.२२ मि. भएकोले तुलनात्मक सेडिमेन्ट घाटा प्रति बर्ष ५००० टन हुन आउँछ । समग्रमा मनहरा नदीको कटान् हुनसक्ने अरू धारहरूको समेत अनुमान गर्ने हो भने करिब १०००० टन घाटा हुने अनुमान गर्न सकिन्छ । बिष्णुमती नदीको मध्यउपल्लो धारमा बगर कटान्को समस्या छ भने यो नदी समग्रमा पीँध कटान्को समस्याबाट ग्रसित छ अथवा यो degrading river मा पर्दछ (Tamrakar 2004a; Adhikari and Tamrakar 2006) । त्यस्तै बल्खु नदीको तल्लो धारमा पीँध कटान् भएको पाइन्छ । यस विपरीत मनमती नदीको उपल्लो धारमा पीँध कटान् भएको पाइन्छ । नख्खु नदीको तल्लो धारमा भन्दा उपल्लो धार मा बढी पीँध कटान् भएको पाइन्छ । यसबाहेक अन्य नदीको अध्ययन विस्तृत रूपमा अझ हुन बाँकी छ । पीँध कटान् नदीको बेसिनको हलचल तथा मानव बाधाका कारण भएको पाइन्छ ।

धेरैजसो बगरहरू मानव बस्ती तथा बाटोको निर्माणबाट अतिक्रमित भएको पाइन्छ । यसबाट मानव बस्तीमा उब्जने फोहर तथा ढल सिधै नदीमा मिलाइएको हुँदा (चित्र नं. ३) प्रदुषण बढ्दो छ । त्यस्तै काठमाडौँ महानगरपालिकाद्वारा नदीछेउ पुरिएका फोहर व्यवस्थित नभएकोले फोहर बाट निस्कने दुर्गन्धले वातावरणमा प्रत्यक्ष असर पुर्‍याइरहेको छ ।

अव्यवस्थित रूपमा ढुङ्गामाटो तथा बालुवाको खानी सञ्चालन र उत्खनन्बाट नदीमा असन्तुलन पैदा भई बर्षाको बेलामा अत्याधिक बगर तथा पीँध कटान् समस्या उब्जिएको छ (Tamrakar 2004a; Tamrakar 2004b; Bajracharya and Tamrakar 2008) । क्षमताको दृष्टिकोणबाट काठ्माडौँका नदीहरू ग्राभल बोक्न सक्षम् छन् तर कम बहावको बेला प्रायः सुक्नगई केवल ढलमात्र बग्ने गर्दछ । नदीको दायाँ तथा बायाँ बगर मा वनस्पतिको विनाशले नदीको इकोसिष्टम्मा ह्रास आएको छ ।

नदीको तल्लो धारमा बि. ओ. डि., सि. ओ. डि., एमोनिया, इसि तथा ब्याक्टेरियाको सङ्ख्या बढ्दो छ तर डि. ओ. अति घट्दो छ (Nepal 2007; Bajracharya and Tamrakar 2008) । नदीको दुषित् पानीका कारणले यसको सम्पर्कबाट रोग सङ्क्रमण हुने सम्भावना त्यस्तै छ ।

चित्र नं. १: काठ्माडौँ उपत्यकामा नदीहरूको अवस्थिति ।

चित्र नं. २: (क) मनहरा नदीको कुर्थली क्षेत्रको बगरमा नदी कटान्बाट भूक्षय भएको दृश्य । (ख) विष्णुमती नदीको ओखलटार क्षेत्रमा नदी कटान्बाट भूक्षय भएको दृश्य ।

काठमाडौँका नदीनालाहरूले मानव सिर्जित विषम परिस्थितिको सामना गरिरहेका छन् र विगत् केही वर्षदेखि यो क्रम बढदो छ । यो अवस्थामा पुग्नुमा मुलतः ज्ञानको कमी, योजना र दूरगामी सोचको अभाव, फोहोर नियन्त्रण तथा नदी संरक्षणको योजनाको अभाव, यथोचित बजेटको अभाव वा कार्ययोजनाको अभाव प्रमुख छन् । फोहर पुनर्चक्रीय व्यवस्थापन परियोजना स्थापना नहुनु पनि अर्को कारण हुन सक्तछ । त्यस्तै चोरीछिपी नदीका ढुङ्गा बालुवाको उत्खनन् हुनु, नदीको सार्वजनिक जग्गा कब्जा हुनु, वनस्पति विनाश गरी संरचना निर्माण गर्नु पनि नदी प्रदुषणका कारणहरू हुन् । यी बाहेक लामो अवधिको प्राकृतिक असर, नदी बेसिनको हलचल तथा जलाशयको भूपरिवर्तनका कारण नदीमा असन्तुलन पैदा हुन्छ र अत्याधिक कटान् हुने वा थिग्रने हुन्छ । प्राकृतिक कारण भन्दा मानव सिर्जित कारकतत्वहरू बढी प्रभावकारी हुनेहुनाले नदीको दुर्गतिको श्रेय मानवमात्रलाई जान्छ ।

नदीको दुरूपयोगबाट उत्पन्न हुने समस्याहरू

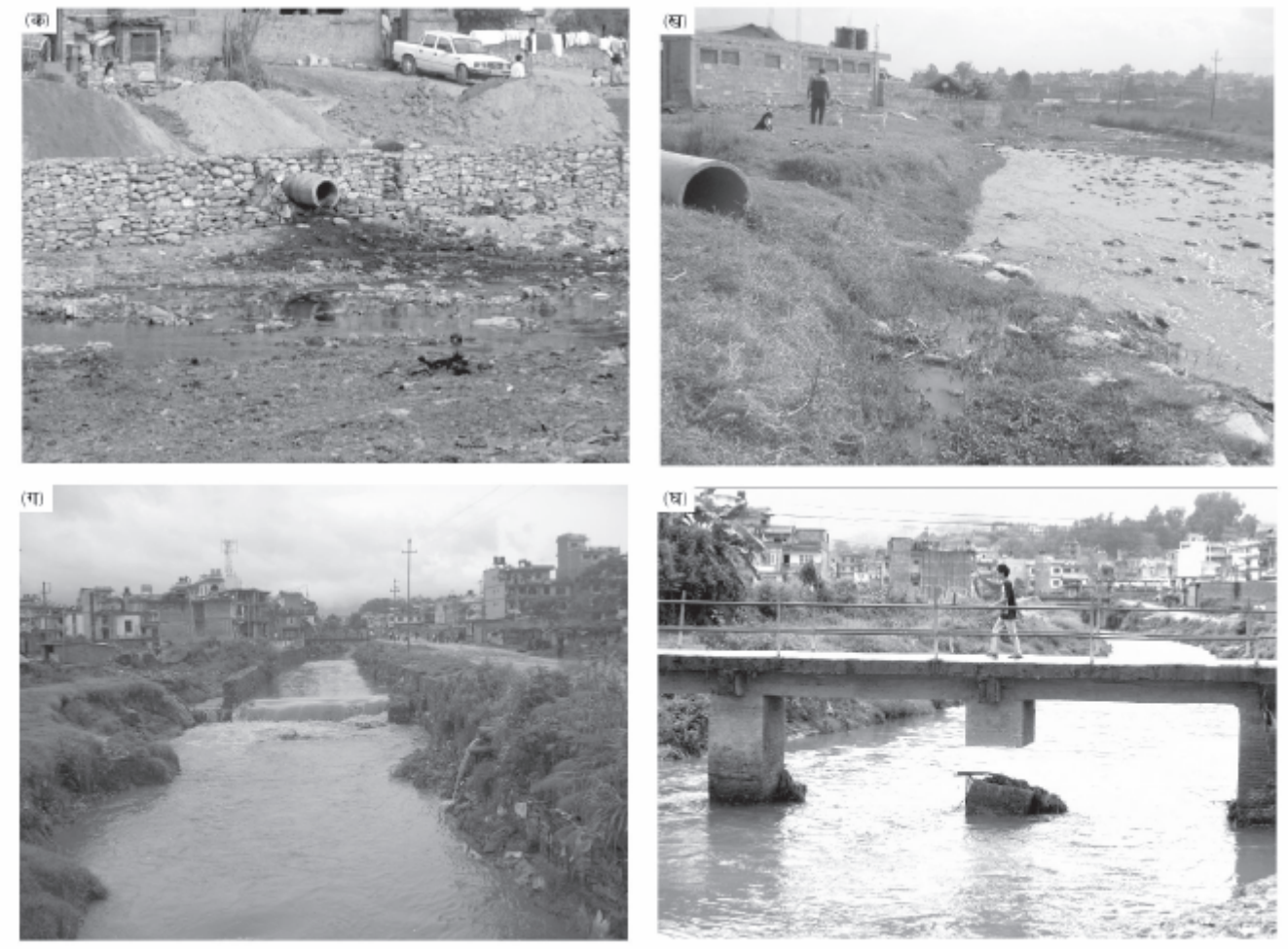
नदीनाला भनेका प्राकृतिक सम्पदा हुन् । यिनको उचित तथा व्यवस्थित तवरबाट सदुपयोग र संरक्षण गर्नसके धेरै फाइदा लिन सकिन्छ । यस विपरीत यसको दुरुपयोगले बिनाश निम्त्याउँछ । दुर्भाग्यवश काठमाडौँका नदीहरू संरक्षणबाट बञ्चित छन् बरु दुरुपयोग भईरहेका छन् । नदीको उचित सदुपयोग र संरक्षणको अभावका कारण वातावरणीय विनाश भविष्यमा अनियन्त्रित हुन सक्तछ । जस्तैः

१. नदीको अनियन्त्रित कटान् भई भूक्षय अत्यधिक र तीव्र हुने,
२. नदीमा बनाईएका संरचना वा पुल भत्कने वा क्षति पुग्ने (चित्र नं. ३ घ),
३. नदीको प्रवाहमा अस्वभाविकपना आउने,
४. नदी पारिस्थितिकी प्रणालीमा ह्रास आउने,
५. नदीको स्वरूपमा कायान्तरण हुने,
६. नदी सम्पदा ढलमा परिणत हुने,
७. ढलयुक्त नदीको सङ्क्रमणबाट वातावरण दुषित हुने, दुर्गन्धित हुने, स्वास्थमा असर पर्ने, महामारी फैलिने,
८. नदीको प्रदुषित पानीबाट भूमिगत जल (groundwater) समेत प्रदुषण हुने,
९. नदीको प्रदुषणबाट युनेस्को वर्ल्ड हेरिटेज् क्षेत्र (जस्तै बौद्ध स्तुप, स्वयम्भुनाथ, पशुपतिनाथ, चाँगुनारायण, काठ्माडौँ दरवार स्क्वायर समेत प्रभावित हुनसक्ने ।

यी समस्याहरूले विकराल रूप लिनु अगावै काठ्माडौँका नदीहरूको पुनर्स्थापन कार्य गर्नु अति जरुरी देखिन्छ ।

नदी पुनर्स्थापन कार्यका चुनौतीहरू

समस्याग्रस्त नदीहरूको पुनर्स्थापन कार्य आजको भोलि तुरुन्त हुनसक्ने कार्य होइन । यसका लागि धेरै पैसा र समय खर्चिनुपर्ने हुन्छ । पुनर्स्थापनका सम्भावना छन् तर चुनौति पनि त्यत्तिकै छन् । पुनर्स्थापन कार्य त्यत्ति सरल छैन । किनभने नदी भनेका रक्तनलि जस्तै हुन् । यो एक सिङ्गो जलमार्ग मात्र नभई संयन्त्रमा स्थापित भएको हुन्छ । यसको उपल्लो धार मा पर्ने असर तल्लो धारमा सर्दछ । त्यस्तै तल्लो धारमा पर्ने असर उपल्लो धारमा गएर प्रतिबिम्बित हुन्छ । स्थानीय धारमा पर्ने असरले दीर्घकालीन् रूपमा नदीको जलाशय स्केलमा असर र असन्तुलन (systemwide instability) पुर्याँउछ । पुनर्स्थापन कार्य अपनाउँदा नदीको सन्तुलन पहिचान गरेर नदीलाई सकभर प्राकृतिक अवस्थामा ल्याउने तरिकाले डिजाईन गर्नुपर्दछ । त्यसैले नदीको पुनर्स्थापन, संरक्षण तथा सदुपयोग गर्न यथोचित अध्ययन, अनुसन्धान, दीर्घकालीन् तथा अल्पकालीन् योजना तर्जुमा र प्रशस्त लगानीको आवश्यकता पर्दछ । त्यसपछि मात्र प्रकृति हेरी नदीको पुनर्स्थापन गनुपर्ने क्षेत्र वा धार र विधिको चयन गरिन्छ । त्यस विपरित नदीको बिस्तृत अध्ययन नगरिकन वा तिनको बानीब्यहोरा अथवा शक्ति सन्तुलन (dynamic equilibrium)



चित्र न. ३: (क) बिष्णुमती नदी किनार चपेर पखाल लगाइएका तथा ढल तस्याइएका दृश्य । यस भागमा नदीलाइ अत्याधिक सङ्कुचित गारिएको छ । (ख) नख्खु खोलाको किनारमा ढलको पाईप तेर्साईएको दृश्य । (ग) बिष्णुमती नदी किनारमा अव्यवस्थित तथा अतिक्रमित बस्तीहरूको दृश्य । (घ) चित्र ग को अलि तल्लो धारमा नदी कटान्ले गर्दा भत्केको जग तथा जोखिमपूर्ण पुलको अवस्था ।

पहिचान नगरी अपनाइएका कुनै पनि कार्यहरू अस्थायी र निरर्थक हुन्छन् । काठ्माडौँका नदीहरू हालको अवस्थाका आइपुग्नका लागि बढ्दो सहरीकरण, सचेतनाको अभाव, फोहोरमा हुने राजनीति आदिले प्रमुख भूमिका खेलेका छन् र यिनको पुनर्स्थापन कार्यमा निम्नलिखित चुनौतिहरू थपिएका छन् ।

१. सतही अध्ययनको आधारमा गरिएका कार्यबाट उत्पन्न हुने नकारात्मक प्रभावबाट ।
२. प्रदूषित तथा असन्तुलित नदीहरूको पहिचान गरी दश बर्षे कार्ययोजना अपनाउने सम्बन्धमा ।
३. नदी संरक्षण सम्बन्धी जनचेतना जगाउने कार्यमा ।
४. नदीमा मिसाइका सम्पूर्ण ढललाई नदीका दुवै किनारमा छुट्टै पाइप लाईनद्वारा सङ्कलन गरी तह लगाउने कार्यमा ।
५. नदीको उपल्लो हिस्सामा पानीको तान्ने कम गर्ने, बर्षाको पानीलाई व्यवस्थित गर्ने र बहाव कायम राख्ने सम्बन्धमा ।
६. नदी कटान् नियन्त्रण गर्ने र कटान्बाट क्षति भएका संरचना पुनर्निर्माण गर्ने बिषयमा ।
७. नदीमा थुपारिएका फोहरका डङ्गुरहरूलाई तह लगाई प्रदुषण मुक्त बनाउने बिषयमा ।
८. नदी छेउका धार्मिक सम्पदालाई जिर्णोद्धार गर्ने कार्यमा ।
९. नदी छेउका करिब ३० देखि ५० मिटर दायाँबायाँ चौडा क्षेत्रलाई पुर्नस्थापन क्षेत्र घोषणा गरी वनस्पतिक पेटी वा पार्क निर्माण गर्ने कार्यमा ।
१०. नदी क्षेत्रमा अनियन्त्रित ढुङ्गाबालुवाको उत्खनन्मा रोक लगाउने सम्बन्धमा ।

चुनौतिहरू धेरै भए पनि काठ्माडौँका स्थानीयवासी, शिक्षण संस्था, अनुसन्धान केन्द्र, स्थानीय निकाय तथा सरकारले हातेमालो गर्दै अगाडि बढ्ने हो भने पुनर्स्थापन कार्य असम्भव छैन। सहरी नदीसम्बन्धी अध्ययन र अनुसन्धान गर्न भूगर्भशास्त्र केन्द्रीय विभागलगायत विज्ञानका अन्य केन्द्रीय विभागबीच समन्वय गरी पुनर्स्थापन, संरक्षण तथा व्यवस्थापन कार्य गर्न महानगरपालिकामा छुट्टै निकाय स्थापना गर्नुपर्ने आवश्यकता देखिएको छ। यसमा अझ ढिलो गर्ने हो भने हाम्रो इतिहासले हामीलाई सराप्ने छ।

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नेपालमा भूकम्प जोखिम न्यूनीकरण : चुनौती तथा उपायहरू

सुधीर रजौरे

पेट्रोलियम अन्वेषण परियोजना, खानी तथा भूगर्भ विभाग, काठमाडौं

पृष्ठभूमि

विश्वमा प्रत्येक वर्ष अनेक किसिमका प्राकृतिक प्रकोपले असर पारिराखेका हुन्छन् । बाढी, पहिरो आँधी, सुनामी, भूकम्प आदि प्राकृतिक प्रकोपका उदाहरणहरू हुन् । कतिपय यस्ता प्रकोपहरूको आगमनको पूर्वसूचना हामीलाई प्राप्त हुन्छ अथवा अनुमान गर्न सक्छौं र पूर्व सतर्कता अपनाउन सक्छौं भने भूकम्प एक यस्तो प्राकृतिक प्रकोप हो जसको भविष्यवाणी हालसम्म असम्भव देखिएको छ । शक्तिशाली भूकम्पले केही सेकेण्डको अन्तरालमा लाखौंको जीवन समाप्त पार्न सक्छ र त्यसैगरी अर बौंको भौतिक क्षति मानव सभ्यताले बेहोर्नुपर्ने हुन्छ ।

सामान्य अर्थमा भूकम्प भनेको पृथ्वीको कम्पन हो । ठूला भूकम्प जाने धेरै कारणहरू हुन्छन् जस्मा टेक्टोनिक प्लेटहरू (tectonic plates) बीचको अन्तरक्रिया एक प्रमुख कारण हो । नेपाल तथा हिमायल क्षेत्रमा जाने भूकम्पहरू टेक्टोनिक प्लेटहरू (tectonic plates) को बीचमा हुने अन्तरक्रियाको कारणले उत्पन्न हुने गर्दछन् । पृथ्वीको माथिल्लो तह (crust) मा रहेका कमजोर भौगर्भिक दरार (geological faults) मा अकस्मात विस्थापन हुँदा भूकम्प उत्पन्न हुन्छन् । करिब पाँच करोड वर्षभन्दा पहिले हालको भारतीय उपमहाद्वीप र तिब्बतको बीचमा टेथिस समुद्र थियो । दक्षिणी दिशाबाट उत्तरतर्फ बिस्तारै सर्दै आइरहेको भारतीय टेक्टोनिक प्लेट (Indian tectonic plate) र उत्तरमा रहेको तिब्बती टेक्टोनिक प्लेट (Tibetan tectonic plate) करिब पाँच करोड वर्ष पहिले एकापसमा ठोक्किएपछि टेथिस समुद्र लोप हुन गयो । उक्त ठोकाइपछि बिस्तारै हिमालय श्रृङ्खलाहरूको निर्माण हुन गएको अनुमान गरिएको छ । हिमालय बन्ने प्रक्रियासँगै तिब्बतबाट दक्षिणतर्फ बग्ने साना नदीहरू थुनिएर थुप्रै तालहरू बने (मानसरोवर आदि) भने ठूला नदीहरू (कोशी, गण्डकी तथा कर्णाली) हिमालय पर्वतलाई काटेर नेपाल हुँदै दक्षिणतर्फ बग्न थाले ।

नेपालमा भूकम्प जानु भनेको एक सामान्य तथा नियमित प्रक्रिया हो । साना भूकम्पहरू दिनहुँ जसो गइराखेका हुन्छन् भने ठूला भूकम्पहरू लामो समयको अन्तरालमा जाने गर्दछन् । नेपालमा तीन म्याग्नेच्युड भन्दा साना भूकम्पहरू प्रत्येक दिन तीनदेखि चारवटा सम्म जाने गरेको पाइएको छ । यस्ता साना भूकम्पहरू न हामीले थाहा पाउँछौं न त तिनले कुनै क्षति नै पुऱ्याउँछन् । यस्ता भूकम्पहरू विशेष प्रकारका यन्त्रहरूले मात्र थाहा पाउन सक्छन र रेकर्ड गर्न सक्दछन् । नेपालमा यस्ता भूकम्पहरूको अभिलेख तथा अध्ययन खानी तथा भूगर्भ विभागले गरिरहेको छ । खानी तथा भूगर्भ विभागका भूकम्प सम्वेदन यन्त्रहरूको सञ्जालले नेपालको कुनै पनि ठाउँमा जाने दुई म्याग्नेच्युडभन्दा माथिका सबै भूकम्प रेकर्ड गर्ने क्षमता राख्दछ ।

भूकम्पले सामान्यतः भूकम्पको केन्द्रबिन्दु नजिकमा बढी असर गर्दछ । भूकम्पबाट कुनै स्थान विशेषमा हुने असर तथा क्षति निम्न कुराहरूमा भर पर्दछन् ।

- उक्त भूकम्पको शक्ति अर्थात् म्याग्नेच्युड ।
- भूकम्पको केन्द्रबिन्दुबाट स्थान विशेषसम्मको दुरी ।
- स्थानीय रूपमा हुने भूकम्पीय तरङ्गहरूको क्षय ।
- स्थानीय भौगर्भिक बनावट : चट्टान भएको स्थानभन्दा कमलो बालुवा तथा माटो भएको स्थानमा बढी क्षति हुन्छ ।
- स्थानीय जनसङ्ख्या : जनसङ्ख्या जति बढी भयो त्यतिनै अनुपातमा मानवीय क्षति हुने सम्भावना रहन्छ ।
- भूकम्प उत्पन्न गर्ने भौगर्भिक बिन्दु अथवा स्थानमा हुने विस्थापनको दिशासँग स्थान विशेषले बनाउने कोण : भूकम्प उत्पन्न गर्ने दरारको अवस्थितिको समानान्तर दिशामा पर्ने स्थानहरूमा अन्य स्थानमा भन्दा बढी क्षति हुने गर्दछ ।
- भूकम्पका तरङ्गहरूको बीचमा हुने रचनात्मक संयोजन : भूकम्पका तरङ्गहरूको धनात्मक संयोजन विशेष गरी उपत्यकाहरूको छेउछाउमा हुनसक्छ जहाँ नजिक रहेका पहाडहरूबाट प्रतिबिम्बित भई आएका तरङ्गहरूको संयोजन मुलतरङ्गसँग रचनात्मक हुन जान्छ ।
- भूकम्प गएको समय : दिउँसो मानिसहरू घरबाहिर रहने भएकाले दिउँसो गएको भूकम्पको तुलनामा रातमा गएको भूकम्पले जनधनको बढी क्षति गर्नसक्छ ।

अहिले नेपालमा गइरहेका ससाना भूकम्पका केन्द्रबिन्दुहरूको बिवरण हेर्दा भूकम्पको श्रोत क्षेत्र नेपालको उत्तरमा उच्च हिमालयको गर्भमा रहेको पाइन्छ र तत्सम्बन्धी विभिन्न अनुसन्धानहरूबाट प्राप्त नतिजाहरू विश्लेषण गर्दा ठूला भूकम्पहरूको केन्द्रबिन्दु पनि सोही क्षेत्रमा रहेको पाइएको छ । निकै ठूलो म्याग्नेच्युड भएको भूकम्प आएको खण्डमा नेपालमा मात्र नभई भारतको उत्तरी क्षेत्र र तिब्बतको दक्षिणी भागमा पनि व्यापक क्षति पुऱ्याउने देखिन्छ ।

भूकम्प प्रकोपका प्रमुख किसिम

सतहको तीव्र कम्पन

भूकम्पको केन्द्रबिन्दुको नजिक रहेका स्थानहरूमा तीव्र कम्पन हुन्छ । केन्द्रबिन्दुबाट टाढा भने कम्पनको तीव्रता घट्दै जाने गर्दछ । भूकम्पको श्रोत क्षेत्रको नजिकमा साना तथा अग्ला घरहरू भत्किने सम्भावना हुन्छ तर भूकम्पका तरङ्गहरू टाढा पुग्दा उच्च आवृत्तिहरू (high frequencies) क्षय भइसकेका हुन्छन् र निम्नआवृत्तिहरू (low

frequencies) को क्षय तुलनात्मक रूपमा कम भएको हुन्छ । यस अवस्थामा कम उचाइका घरहरू भत्किने सम्भावना कम हुन्छ तर अग्ला घरहरूमा धेरै गुणा क्षति हुनसक्छ ।

भूमिको तरलीकरण

भूमिगत पानी पाइने क्षेत्रहरूमा जमिनमन्तिरको माटो तथा बालुवाको बीचमा पानी भरिएको हुन्छ । भूकम्पका तरङ्गहरूले बेस्सरी हल्लाउन थालेपछि माटो तथा बालुवाका कणहरूको बीचमा रहेको सङ्गठन (cohesion) कमजोर हुनजान्छ र त्यस्तो जमिनले तरल पदार्थको जस्तो व्यवहार गर्दछ । यसरी तरलीकरण भएको स्थानमा बनाइएका संरचनाहरू नभत्किए पनि ढल्न सक्छन् अथवा ढल्किन सक्छन् र प्रयोगहीन हुन पुग्छन् । तरलीकरण विशेष गरी बालुवाको मात्रा बढी तथा भूमिगत जलस्तरको सतह जमिनबाट नजिक रहेको स्थानमा हुने सम्भावना रहन्छ । नेपालको दक्षिणी तराई क्षेत्र तथा उपत्यकाहरू भएर बग्ने नदीका किनारहरूमा तरलीकरण हुन सक्ने प्रबल सम्भावना देखिन्छ ।

जोखिममा अत्यावश्यक सुविधा

आजको युगमा विद्युत, खानेपानी, सञ्चार, सडकसञ्जाल, पुलहरू, विमानस्थल, तेलभण्डार आदिको ठूलो महत्व छ । ठूलो भूकम्प गएको खण्डमा यस्ता सेवासुविधाहरू महिनौँसम्म पनि प्रभावित हुन सक्छन् र हाम्रो जीवन निकै कष्टकर बनाइदिन सक्छन् । यसैगरी भूकम्प गइसकेपछि गरिने उद्धार, राहतवितरण र पुर्स्थापनाको कार्यमा पनि अवरोध पुग्न सक्छ ।

पहिरो

भूकम्प जाँदा जमिनको तीव्र कम्पनले गर्दा पहाडी क्षेत्रमा पहिरो जान सक्छ । बर्षाको समयमा पानी बढी पर्ने कारणले गर्दा जमिन पानीले भिजेको हुन्छ र कमजोर हुन्छ । यदि यस्तो समयमा ठूलो भूकम्प गएको खण्डमा ठूला पहिराहरू जान सक्छन् र पहाडी क्षेत्रमा निर्माण गरिएका बाँध भत्किन सक्छन् र सडकहरू धेरै दिनसम्म अवरुद्ध हुन सक्छन् । हिमतालको विष्फोट हुँदा ठूलो बाढी आएर क्षति हुनसक्छ । भूकम्पकृत पहिरोले नदीको प्रवाह रोकेर केही समयको लागि ताल बनाउन सक्छन् । यस्ता तालहरू फुट्न गएमा तल्लो तटीय भागमा ठूला बाढीहरू आउने सम्भावना रहन्छ ।

भूकम्प जोखिम न्यूनीकरणका चुनौती

कमजोर भौगर्भिक बनावट, निरन्तर रूपमा भइरहने भौगर्भिक उथलपुथल, अवैज्ञानिक भूउपयोग, अव्यवस्थित सहरीकरण, तीव्र जनसङ्ख्या वृद्धि, जनताको कमजोर आर्थिक स्थिति आदि भूकम्प जोखिम तथा यसको न्यूनीकरणका लागि प्रमुख चुनौतीहरू हून । नेपालमा, विशेष गरी, काठमाडौँ उपत्यकाका पुराना बस्तीहरूमा साँघुरा गल्लीहरू भएकाले ठूलो भूकम्प गएको खण्डमा उद्धार गर्न र अत्यावश्यक सेवाहरू समेत उपलब्ध गराउन कठीन हुनेछ । काठमाडौँ उपत्यकाका सहरी क्षेत्रमा हाल बहुतले घरहरू बनिरहेका छन् तर उक्त स्थानको भौगर्भिक तथा भूप्राविधिक अध्ययन गरेको पाईदैन वा गरेको भए पनि सिफारिस अनुसार काम गरेको पाईदैन । काठमाडौँ उपत्यका, यस्तै अन्य उपत्यका तथा तराईको भूगर्भ कमजोर एवं जटिल छ । यस्ता स्थानहरूमा भूकम्पका तरङ्गहरू पुगेमा यसको amplitude एक्कासी बढ्न गई कम्पनको समयावधी पनि लामो हुन पुग्छ र जमिनको तरलीकरण पनि व्यापक रूपमा हुन सक्दछ ।

भूकम्प जोखिम न्यूनीकरणका उपायहरू

भूकम्प जोखिम न्यूनीकरणको लागि सबभन्दा पहिले भूउपयोग नीति बनाउन आवश्यक छ । आज जग्गा प्लटिङको नाममा तीव्र गतिमा उर्वर भूमिको विनास भइरहेको छ । अनियन्त्रित रूपमा भइरहेको शहरीकरण भूकम्पीय जोखिमको दृष्टिकोणबाट पनि खतरनाक बन्दै गइरहेको छ । खेतीयोग्य जमिन जोगाउन तथा भौकम्पिक जोखिम न्यूनीकरण कार्य गर्नको लागि नेपालको भूकम्पीय बिभाजन गर्नु आवश्यक छ । यसरी गरिएको विभाजनबाट कम जोखिम देखिएका स्थानहरूमा शहरहरूको विकास गर्न प्रोत्साहन गर्नुपर्दछ र बढी जोखिम देखिएका स्थानहरूमा यस्तो कार्य निरुत्साहित गरिनुपर्दछ वा रोकिनुपर्दछ ।

भूकम्पीय जोखिम बढी देखिएका स्थानहरूमा जोखिमको अनुपात हेरी भूकम्प प्रतिरोधक भवन तथा संरचनाहरूको निर्माण गर्नुपर्दछ भने पहिले नै बनिसकेका यस्ता भौतिक संरचनाहरूको सुदृढीकरण गनुपर्दछ । यस बाहेक भूकम्प जानु अघि, गएको समयमा तथा गइसकेपछि हामीले अपनाउनु पर्ने सावधानी अपनाउन सक्यौं भने पनि भूकम्पबाट हुने क्षति निकै कम गर्न सकिन्छ ।

नेपालमा तीव्र भूकम्पनको अध्ययन गर्न बाँकी छ । यस्को लागि तीव्र कम्पसम्वेदन यन्त्रहरूको सञ्जालको स्थापना गर्नुपर्दछ । यस प्रकारको अध्ययनबाट नेपालमा भूकम्पका तरङ्गहरूको शक्ति कसरी क्षय हुन्छ भन्ने थाहा हुनेछ र भूकम्पीय जोखिम अनुमानमा यसले सहयोग गर्दछ । यसका अतिरिक्त उपलब्ध तथ्याङ्कहरूले ठूला विकास संरचनाहरूको निर्माणपूर्व गरिने अध्ययनमा पनि सहयोग पुऱ्याउनेछन् । भूकम्प जोखिमको अनुमान केही बर्षको अन्तरालमा निरन्तर गर्नुपर्दछ किनभने हामीसँग निरन्तर भूकम्पका तथ्याङ्कहरू थपिइरहेका हुन्छन् । विश्वमा नयाँ प्रविधिको विकास भइरहेको हुन्छ र हामी पनि थप अनुभव तथा ज्ञान हासिल गरि सकेका हुन्छौं ।

AWARD OF THE HONORARY FELLOWSHIP OF THE NEPAL GEOLOGICAL SOCIETY

The Nepal Geological Society had conferred upon the **Honorary Fellowship** of the Nepal Geological Society to Professor Dr. Gerhad Fuchs of University of Vienna, Austria and Professor Dr. Madhab Prasad Sharma, Trubhuvan University, Nepal on the occasion of 30th annual general body meeting of the Nepal Geological Society on September 2009 in recognition of their contribution towards scientific research and development of the Himalaya.

Prof. Dr. Gerhard Fuchs, Austria

Prof. Dr. Gerhard Fuchs was born as a son of Johann Fuchs and his wife Maria on 6th of March 1934 in Vienna. When he was only about 11 years old, his father died as a prisoner of war in Yugoslavia in 1945 and her mother also died later in the same year. He completed his Lower, Middle and Higher Secondary Schooling in Vienna and did his undergraduate degree in 1953. His school education was made possible by a scholarship for orphans from the Government of the Republic of Austria. From 1953 to 1957 he studied Geology in the University of Vienna and completed his Doctor of Philosophy (PhD) in 1957. He got married with Dr. Ingolde Fuchs in 1959. Now he is a father of three sons who were born in 1962, 1964, 1966.

Prof. Fuchs worked as a scientific team member of the Austrian Greenland Expedition in 1957. Later in 1958 he joined the Geological Survey of Austria (Geologischen Bundesanstalt). His, one of the most important work was the preparation of the Geological Map of Austria. In 1972 he became the head of a development aid project in Afghanistan. And then he took part in several Geological research works/expeditions in the Himalayan Regions under the Zahlreichen Ex-peditionen: 1963 in Nepal; 1964 India and Nepal; 1967 Nepal; 1969 India and Pakistan; 1973 Nepal; 1976 Ladakh (India), Garhwal (India); 1978 Spiti (India); 1980, 1983 and 1985 Ladakh; 1987 Nepal; 1988, 1990, 1992 and 1995 Ladakh, 1996 Nepal, 1998 and Nepal, 2004 Arunachal Pradesh and Assam (India). Financial support for Himalayan expeditions was provided by the Austrian Science Fund (FWF). Expeditions in 1987, 1988 and 1990 were financed by funding from German Research Council (DFG). He has put his mark on the geological research in the Himalaya and the Alps.

Prof. Fuchs is a pioneering geologist of the Himalaya. From early sixties to as late as 2004 he made various geological research expeditions to the Himalaya. He has mapped a large part of this terrain from Kashmir to Assam. His publication of the regional geological map of the Himalaya is a classic work. Much of the early knowledge on the geology of Tethys Himalaya and the area of MCT zone in Nepal and India comes from Prof. Fuch's work. A great number of published geological maps prepared by Dr. Fuchs are important resource materials for future research in the Himalaya.

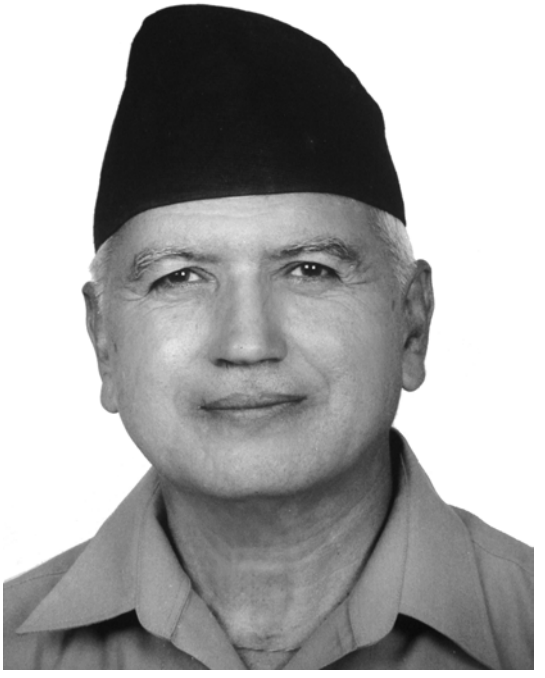
In 1982 **Prof. Fuchs** also started teaching in the Geology Department in the University of Vienna. Since 1994 he became an A. O. University Professor (Extraordinary University Professor) in the same university. His main work was to provide field training to the students of Geology and deliver Special Lectures on Himalayan Geology. He also continued geological mapping of the Bohemian Massif in Austria. In 1993 he organized the 8th Himalaya-Karakorum-Tibet-Workshop in Vienna, Austria which was attended by more than 150 participants. Prof. Fuchs worked with more than 60 counterparts (Co-workers) from 15 countries and was successful in completing the research projects. He has published over 40 research papers on the Himalayan geology and nearly an equal number of publications on the geology of Alps and other regions. He has also prepared a large number of unpublished maps and reports, field reports, published field reports, book reviews and lectures in Austria and abroad. In 1985 he received the prestigious **"Golden Badge of Honour"** a national honour from the Government of the Republic of Austria. Presently he lives in Lower Austria. He was honored by the **AWARD OF THE HONORARY FELLOWSHIP** of the Nepal Geological Society in 2009 AD.

Prof. Dr. Madhab Prasad Sharma, Nepal

Prof. Dr. Madhab Prasad Sharma was born in 1943 in Dhankuta district in Eastern Nepal. He had his school education from Gokundeshwar High School, Dhankuta and passed School Leaving Certificate (SLC) Examination in 1959. He finished his Intermediate of Science education from Lucknow, India in 1961. Later, under the Scholarship programme of the Government of Nepal, he went to the former Soviet Union (USSR) and completed the M. Sc. degree in Geology from Moscow State University in 1967 and later Ph. D. from the same university on 15th of March 1978.

Prof. Sharma returned to Nepal after completion of M.Sc. degree from USSR, and joined the Department of Geography and shortly later Department of Geology, Tri-Chandra College (presently the Tri-Chandra Multiple Campus), Tribhuvan University, and started teaching geology since 1967. Since then he served in the Central Department of Geology, Tribhuvan University, Kirtipur until his retirement in 2004. In 1985 Prof. Sharma was invited as Fellow of Matsumae International Foundation at Hokkaido University, Japan for six months. Prof. Sharma has served as a Head of Department of Geology at Tri-Chandra Campus as well as at the Central Department of Geology, Tribhuvan University, Kirtipur. He was the Executive Director of Research Centre for Applied Science and Technology (RECAST), Tribhuvan University in 1990-1991 and the Rector of Tribhuvan University from 1995-1999 and presently serving as the Vice-Chancellor of Tribhuvan University since 2007.

Prof. Sharma has a very long career of over 40 years in the academic field. He is honored as an educationist and a education policy maker. He has contributed significantly in the establishment and development of Geology Departments in Tribhuvan University and thus is a pioneer in the Earth science education in Nepal. Most geologists presently working in Nepal are the products of Tribhuvan University and thus they are his fellow students. He had contributed in the geological site investigation of many projects in Nepal. He has produced many research articles. Professor Sharma is also a member of many geoscientific societies and social organizations. He is the life member (LM-35) of Nepal Geological Society (NGS), member of Nepal Engineering Association (NEA), Nepal Engineering Council (NEC) and Russia Friendship Society (Federation). He is the first president and active member of Mitra Kunj. Prof. Sharma is associated with Netrajyoti Sangh and Consumers Group, Nepal. He also worked as the General Secretary of Nepal Geological Society in 1990.



Prof. Sharma is mostly known for his contribution for researching the granite massifs of former Soviet Union (USSR) and Nepal Himalaya. He had made a research in Dupukh Granitic Massif (North Caucasus) for his PhD degree from Moscow State University. After this he did significant contributions to granite deposits of Nepal. The pioneer research in this field included mineralogy and geochemistry of Palung Granite massif; chemical characteristics of some granitic rocks in central Nepal; geochemistry of Ampipal Pluton; Gamma-ray spectrometer analysis of Ampipal alkaline massif, western Nepal, Lesser Himalaya etc. Professor Sharma worked with many counterpart scientists from different countries including France, Germay, Japan, Russia, India and United States of America. His collaborative research works are documented in numerous publications co-authored with them.

He was honored by the **AWARD OF THE HONORARY FELLOWSHIP** of the Nepal Geological Society in 2009 AD.

CONGRATULATIONS

The Nepal Geological Society express their heartiest congratulation to Professor Dr. Prakash Chandra Adhikary, Life Member (LM 08) of the Nepal Geological Society for his appointment by the Government of Nepal as **Secretary** of the Nepal Academy of Science and Technology (NAST), Ministry of Science, Government of Nepal.

Prof. Dr. Prakash Chandra Adhikary

Mr. Sarbajit Prasad Mahato

The Nepal Geological Society extend their heartiest congratulation to Mr. Sarbajit Prasad Mahato, Life Member (LM 219) of the Nepal Geological Society who has been working in the capacity of **Director General** at the Department of Mines and Geology, Ministry of Industry, Government of Nepal.

The Nepal Geological Society is pleased to congratulate Mr. Shri Ram Maharjan, Life Member (LM 217) of the Nepal Geological Society who has been promoted to the position of **Deputy Director General** at the Department of Mines and Geology, Ministry of Industry, Government of Nepal.

Mr. Shri Ram Maharjan

Mr. Uttam Bol Shrestha

The Nepal Geological Society is highly elated to extend the heartiest congratulation to Mr. Uttam Bol Shrestha, Life Member (LM 224) of the Nepal Geological Society who has been promoted to the position of **Superintendent Mining Engineer** at the Department of Mines and Geology, Ministry of Industry, Government of Nepal.

The Nepal Geological Society express their heartiest congratulation to Mr. Hifzur Rahman, Life Member (LM 99) of the Nepal Geological Society who has been promoted to the position of **Superintendent Geologist** at the Department of Mines and Geology, Ministry of Industry, Government of Nepal.

Mr. Hifzur Rahman

Mr. Shyam Bahadur KC

The Nepal Geological Society extend their heartiest congratulation to Mr. Shyam Bahadur KC, Life Member (LM 101) of the Nepal Geological Society who has been taking an inchage of **Acting Project Chief** at the Petroleum Exploration Promotion Project, Department of Mines and Geology, Ministry of Industry, Government of Nepal.

The Nepal Geological Society is pleased to congratulate Mr. Moti Bahadur Kunwor, Life Member (LM 103) of the Nepal Geological Society who has been promoted to the position of **Superintendent Engineering Geologist** at the Department of Electricity Development, Ministry of Energy, Government of Nepal.

Mr. Moti Bahadur Kunwor

Mr. Siddhi Pratap Khann

The Nepal Geological Society is highly elated to extend the heartiest congratulation to Mr. Siddhi Pratap Khann, Life Member (LM 177) of the Nepal Geological Society who has been promoted to the position of **Deputy Director General** at the Groundwater Division, Department of Irrigation, Ministry of Irrigation, Government of Nepal.

The Nepal Geological Society expresses the heartiest congratulation to Mr. Sagar Kumar Rai, Life Member (LM 266) of the Nepal Geological Society who has been promoted to the position of **Chief Hydrogeologist** at the Department of Irrigation, Ministry of Irrigation, Government of Nepal.

Mr. Sagar Kumar Rai

The Nepal Geological Society is immensely elated to extend the heartiest congratulation to Dr. Ranjan Kumar Dahal, Life Member (LM 398) of the Nepal Geological Society, for receiving the **Nepal Vidhya Bhusan-Ka** medal from the first President of Nepal, for his Ph. D. degree. The Society also congratulates him for receiving the **Youth Science and Technology Award- 2009** of Nepal Academy of Science and Technology (NAST) and for his nomination by the Nepal Academy of Science and Technology as an Associate Academician in 2010.

Dr. Ranjan Kumar Dahal

Dr. Santa Man Rai

The Nepal Geological Society express their heartiest congratulation to Dr. Santa Man Rai, Life Member (LM-202) of the Nepal Geological Society, for receiving the **Nepal Education Award-2066** from the Ministry of Education, Government of Nepal in 2010.

The Nepal Geological Society extends its heartiest congratulation to Mr. Ram Prasad Sharma (LM 492) for his appointment as a **Campus Chief** of Institute of Forestry, Hetauda Campus, Hetauda.

Mr. Ram Prasad Sharma

Dr. Basant Raj Adhikari

The Nepal Geological Society expresses the heartiest congratulation to Dr. Basanta Raj Adhikari (LM 535) for obtaining a **Ph. D. degree** from the Department of Geodynamics and Sedimentology, University of Vienna, Vienna, Austria in December, 2009. The topic of his dissertation was **Sedimentology and basin analysis of Thakkhola-Mustang graben, Central Nepal.**

The Nepal Geological Society is immensely pleased ro express the heartiest congratulation to Dr. Sunil Kumar Dwivedi (LM 522) for obtaining a **Ph. D. degree** from the Department of Physics and Earth Science, University of the Ryukyus, Okinawa, Japan in 2009. The topic of his dissertation was **Numerical Modeling of Continental Extension to Collision: Examples from the Red Sea, Gulf of Suez and Anatolia.**

Dr. Sunil Kumar Dwivedi

NEW MEMBERS OF THE NEPAL GEOLOGICAL SOCIETY

Member no.	Name	Address
LM 606	**Mr. Murari KHATIWADA**	**Off. Add:** Sarkeys Energy Center, University of Oklahoma, Norman , USA **Email:** khatiwada1@gmail.com
LM 607	**Mr. Rishi GADTAULA**	**Home Add:** Kapan-3, Kathmandu, Nepal **Tel:** 9841368768, **Email:** rgprashil@yahoo.com,
LM 608	**Dr. Dwarika MAHARJAN**	**Home Add:** Lalitpur, Nepal **Email:** dwarica_maharjan@yahoo.com
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M 610	**Mr. Shiva BASNET**	**Off. Add:** Kulekhani III Hydroelctric Project, Makwanpur, Nepal **Tel:** 98941291450, **Email:** gorkhalishiva@gmail.com
LM 611	**Mr. Manoj KUMAR**	**Off. Add:** Tractebel Engineering Pvt. Ltd, 10-A. Shivaji Marg, New Delhi-110015, India **Email:** manoj_kumar02006@rediffmail.com
LM 612	**Mr. Ram Prasad GHIMIRE**	**Off. Add:** Department of Mines and Geology, Lainchaur, Kathmandu, Nepal **Email:** rnksghimire@gmail.com
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M 614	**Mr. Kaushal JHA**	**Off. Add:** GPO Box: 5720, Multidisciplinary Consultancy, Kupondal, Kathmandu, Nepal **Tel:** 9841518999, **Email:** kkaushaljha@yahoo.co.in
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AM 18	**Mr. Prem Nath PAUDEL**	**Home Add:** Boharagaun-9, Baglung, Nepal **Email:** premsagar1@yahoo.com
AM 19	**Mr. Bhupati NEUPANE**	**Home Add:** Khopland-3, Gorkha, Nepal **Email:** bhupati.neupane@yahoo.com
AM 20	**Mr. Babu Ram GYAWALI**	**Home Add:** Thanapani-Gulmi, Nepal **Tel:** 9841637933, **Email:** anuj431@yahoo.com

AM: Associate Member; LM: Life Member; M: Member

ANNOUNCEMENT

Sixth Nepal Geological Congress (NGC-VI)
15 - 17 November 2010, Kathmandu, Nepal

On the occasion of its 30th Anniversary Nepal Geological Society (NGS) is going to organize Sixth Nepal Geological Congress under the **Theme "Geology, Natural Resources, Infrastructures, Climate Change and Natural Disaster"** on 15 - 17 November 2010 at Kathmandu, Nepal.

The **Sub-Themes are:**
* Regional Geology, Stratigraphy and Tectonics
* Mineral Resources and Development
* Oil and Natural Gas (Energy Minerals)
* Water Resources and Hydropower Development
* Hydrology, Engineering Geology and Environment Protection
* Climate Change
* Natural Disaster
* Seismology and Seismotectonics
* Quaternary Geology and Urban Geology
* Geo-science Education

There will be two **Special Sessions** on: (1) **Seismology, Seismotectonics and Seismic Hazards**
(2) **Global Warming and Climate change**

Field Excursion:
The main part of the congress will be followed by two very interesting post congress Field Excursions: EX-1 (6 days) and EX-2 (1 Day).

So far we have received just over 180 abstracts of the research papers from 27 countries for presentation in the congress. In addition to the general research papers 5 Keynote papers, 5-6 Special papers and few Posters will be presented. This is one of the best opportunities for all of us to meet very well known Geoscientists from five continents and shear your research findings, and exchange your views.

Important Dates and Deadlines

Release of Third / Final Circular:	30 September 2010
6th Nepal Geological Congress:	15 - 17 November 2010
Submission of Full Paper:	17 November 2010
Field Excursion EX-1:	18 - 23 November 2010
Field Excursion EX-2:	18 November 2010

All the members of NGS and other interested persons/ institutions/ NGOs and INGOs etc. are kindly requested to read First and Second Circular of the Congress by visiting the website:**www.ngs.org.np**
Or send e-mail to get the circular in any of the following e-mail address:
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Nepal Geological Society
P.O. Box 231
Kathmandu, Nepal

Instructions to contributors to NGS Journal or Bulletin

Manuscript

Send a disk file (preferably in MS Word) and three paper copies of the manuscript, printed on one side of the paper, all copy (including references, figure captions, and tables) double-spaced and in 12-point type with a minimum 2.5 cm margin on all four sides (for reviewer and editor marking and comment). Include three neat, legible copies of all figures. Single-spaced manuscripts or those with inadequate margins or unreadable text, illustrations, or tables will be returned to the author unreviewed.

The manuscripts and all the correspondences regarding the Journal of Nepal Geological Society should be addressed to the Chief Editor, Nepal Geological Society, PO Box 231, Kathmandu, Nepal (Email: publication@ngs.org.np).

The acceptance or rejection of a manuscript is based on appraisal of the paper by two or more reviewers designated by the Editorial Board. Critical review determines the suitability of the paper, originality, and the adequacy and conciseness of the presentation. The manuscripts are returned to the author with suggestions for revision, condensation, or final polish.

After the manuscript has been accepted, the editors will ask the author to submit it in an electronic format for final processing. Manuscripts are copy edited. Final changes must be made at this time, because no galley proofs are sent to authors.

Illustrations

Identify each figure (line drawing, computer graphic, or photograph) with the author's name, and number consecutively, at the bottom, outside the image area. Never use paper clips or tape on illustrations and do not write with pen on the back of figure originals or glossy prints. Where necessary, mark "top". Keep the illustrations separate from the text, and include a double-spaced list of captions. Do not put captions on the figures themselves.

Prepare clean, clear, reproducible illustrations that are drafted at a size not more than twice the publication size. All lettering on illustrations must be drafted or laser printed, not typed or handwritten. Put type, labels, or scales directly on a photograph rather than on a separate overlay. Use graphic scales on illustrations; verbal scales (e.g., "x200") can be made meaningless by reduction of an illustration for printing. Calibrate graphic scales in metric units. Indicate latitude and longitude on maps. Plan all type sizes large enough so that the smallest letters will be at least 1.5 mm tall after reduction to publication size. For review purposes, copies of illustrations must be legible and relatively easy to handle, and any photographs must be direct prints. Do not send original illustrations until asked to do so. Keep at least one copy of all illustrations, as the NGS cannot be responsible for material lost in the mail. For colour figures, authors must bear all costs, and about $50 per colour figure/plate will be charged.

Style

Authors are responsible for providing manuscripts in which approved geological and other scientific terminology is used correctly and which have no grammar or spelling errors. Authors must check their manuscripts for accuracy and consistency in use of capitalisation, spelling, abbreviations, and dates.

Abstract

The abstract should present information and results in capsule form and should be brief and objective, containing within a 250-word maximum the content and conclusions of the paper. The topic sentence should give the overall scope and should be followed by emphasis on new information. Omit references, criticisms, drawings, and diagrams.

Captions

Make captions precise and explain all symbols and abbreviations used. Type captions in consecutive order, double-spaced. Do not put captions and figures on the same page.

References

All references mentioned in the text, figures, captions, and tables must be listed in the References section. Only references cited in the paper are to be listed. For example:

Auden, J. B., 1934, Traverses in the Himalaya. Rec. Geol. Surv. India, v. 69(2), pp. 123–167.

Todd, D. K., 1980, *Groundwater Hydrology*. John Wiley & Sons, Singapore, 535 p.

Tokuoka, T. and Yoshida, M., 1984, Some characteristics of Siwalik (Churia) Group in Chitwan Dun, Central Nepal. Jour. Nepal Geol. Soc., v. 4, (Sp. Issue), pp. 26–55.

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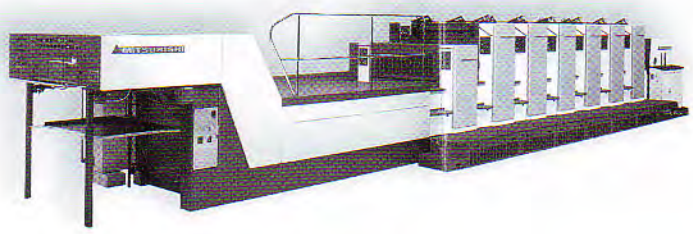

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